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PROCEEDINGS

OF THE

♦ ♦ INDIANA ♦ ♦

Engineering ♦ Society

OF THE

STATE OF INDIANA,

AT ITS

ELEVENTH ANNUAL MEETING,

HELD IN

INDIANAPOLIS, JAN. 20, 21 AND 22, 1891,

TOGETHER WITH

Constitution, By-Laws and Other Valuable Matter.

WM. B. BURFORD, PRINTER, INDIANAPOLIS.

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Thos. Charlton Van Nuys, Professor of Chemistry.
Orrin Benner Clark, Professor English Language and Literature.
Horace Addison Hoffman, Professor of Greek.
Richard Gause Boone, Professor of Pedagogies.
Gustaf Karsten, Professor of Germanic Languages.
William Lowe Bryan, Professor of Philosophy.
Joseph P. Naylor, Professor of Physics.
Charles H. Gilbert, Professor of Zoology.
Earl Barnes, Professor of History.
David Demaree Banta, Dean of Law Department.
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John E. Matzke, Professor of Romance Languages.
Rufus L. Green, Professor of Pure Mathematics.
Jas. A. Woodburn, Professor of American History.
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Wm. B. Elkin, Acting Professor of Philosophy.
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Arthur Lee Foley, Instructor in Physics.
Schuyler C. Davisson, Instructor in Mathematics.
Claude E. Siebenthal, Assistant in Geology.
David M. Mottier, Assistant in Botany.

ADDRESS,

J. M. COULTER, President,

BLOOMINGTON, INDIANA.

2003
76

PROCEEDINGS

OF THE

Indiana Engineering Society

OF THE

STATE OF INDIANA

AT ITS

ELEVENTH ANNUAL MEETING,

HELD AT

INDIANAPOLIS JAN. 20, 21 and 22, '91,

TOGETHER WITH

The Constitution, By-Laws and other Valuable Matter.

INDIANAPOLIS:

WM. B. BURFORD, PRINTER AND BINDER.

1891.

YVES
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OFFICERS FOR 1891.

R. I. MORRISON, President Knightstown, Ind.
 L. S. ALTER, Vice-President Remington, Ind.
 J. R. BROWN, Recording Secretary Frankfort, Ind.
 G. M. CHENEY, Corresponding Secretary Logansport, Ind.
 H. B. FATOUT, Treasurer Indianapolis, Ind.

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R. I. MORRISON. * GEO. M. CHENEY. W. A. OSMER.
 R. H. WALLS. JACOB NORRIS.

LEGISLATIVE COMMITTEE.

JACOB NORRIS. L. S. ALTER. M. H. DOWNEY.

COMMITTEE ON DRAINAGE.

L. S. ALTER. W. M. WHITTEN. CRAVEN SMITH.

COMMITTEE ON ENGINEERING AND SURVEYING.

H. B. FATOUT. C. G. H. GOSS. J. C. PULSE.

COMMITTEE ON PUBLIC HIGHWAYS AND BRIDGES.

W. M. WHITTEN. J. R. BROWN. THOS. FINLEY.

COMMITTEE ON INSTRUMENTS, BLANKS AND RECORDS.

G. M. CHENEY. J. L. ROMACK. A. T. S. KIST.

COMMITTEE ON STATISTICS.

J. F. O'BRIEN. A. W. SMITH. R. H. WALLS.

COMMITTEE ON PRINTING.

J. R. BROWN. R. A. HOWARD. JACOB NORRIS.

LIST OF MEMBERS.

NAMES.	POSTOFFICE.	COUNTY.
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*Allen, L. M	Ft. Wayne	Allen.
Alter, Lewis S	Remington	Jasper.
Bacon, F. M	Terre Haute	Vigo.
Baker, J. E	Indianapolis	Marion.
Baker, Prof. T. O.	Champaign	Champaign, Ill.
Barton, F. M.	Bluffton	Wells.
Beavers, M. H	Covington	Fountain.
Bortner, H. S	Albion	Noble.
Brennon, James H	Shoals	Martin.
Brown, Chas. C.	Terre Haute	Vigo.
Brown, J. R	Frankfort	Clinton.
Butler, Thomas M		Tipton.
Campbell, John T	Rockville	Parke.
Carr, Thomas	Medora	Jackson.
Carter, Calvin	Osgood	Ripley.
Cheney, George M	Logansport	Cass.
Clark, James A	Danville	Hendricks.
Cottingham, E. F	Noblesville	Hamilton.
Coyner, John V	Sugar Creek	Hancock.
Clogston, Wm. W	Bloomfield	Greene.
Craig, J. W	Greensburg	Decatur.
Carmichael, Wm. P	State Line	Warren.
Danish, J. J	Rockville	Parke.
Downey, Morton H	Rushville	Rush.
Fatout, Hervey B	Indianapolis	Marion.
Femwick, J. D.	Daleville	Delaware.
Fisher, John	Crown Point	Lake.
Fries, Winfield S	Greenfield	Hancock.
Finley, Thomas	Shelbyville	Shelby.
Gilbert, Newton W	Angola	Steuben.
Grubb, Henry	Ferndale	Parke.
Goss, Curtis G. H	Martinsville	Morgan.
Hardman, T. A	Brookville	Franklin.
Harrell, R. L	Fowler	Benton.
Harris, George W	Terre Haute	Vigo.
Hiatt, Spencer	Martinsville	Morgan.
Hargrave, Charles A	Danville	Hendricks.
Howard, R. A	Richmond	Wayne.
Hill, William B	Frankfort	Clinton.
Hougham, W. T	Franklin	Johnson.
Horan, Michael	Peru	Miami.
Isley, William H.	Shelbyville	Shelby.
Johnson, T. J	New Harmony	Posey.
Jackson, C. S	Peru	Miami.
Kist, Amos T. S	Warsaw	Kosciusko.
Knight, Frank	Wabash	Wabash.

*Deceased.

LIST OF MEMBERS—Continued.

NAMES.	POSTOFFICE.	COUNTY.
Leach, D. A	Franklin	Johnson.
Lesley, J. P	Winchester	Randolph.
Malott, John B	Bedford	Lawrence.
Markey, S. T	Bluffton	Wells.
Mayfield, Robert P	Vincennes	Knox.
McCarter, George W	Warsaw	Kosciusko.
McConnell, Ira	Crawfordsville	Montgomery.
Miles, Chas. W	San Jacinto	Jennings.
Miller, S. J	Rochester	Fulton.
Morrison, Rob't I	Knightstown	Henry.
Murphy, Geo. S	Shelbyville	Shelby.
Murry, E. C	Marion	Grant.
Neal, C. F. S	Lebanon	Boone.
North, A	Plymouth	Marshall.
Norris, Jacob	Crawfordsville	Montgomery.
O'Brien, Wm. G	Kokomo	Howard.
Orear, M. F	Lebanon	Boone.
Osmer, Walter A	Logansport	Cass.
Overman, Lindley M	Marion	Grant.
O'Brien, J. F	Cloverdale	Putnam.
*Pearce, Geo. W	Martinsville	Morgan.
Piatt, Isaiah	Lagrange	Lagrange.
Polk, Alex H	Princeton	Gibson.
Pulse, Jas. C	Greensburg	Decatur.
Phillips, A. E	Lafayette	Tippecanoe.
Quig'ey, John J	Washington	Daviess.
Rogers, C. E	Portland	Jay.
Root, Lewis B	Goshen	Elkhart.
Russell, Albert M	Winchester	Randolph.
Romack, Jas. L	Tipton	Tipton.
Rader, M. A	Monticello	White.
Sanders, James	Westfield	Hamilton.
Saunders, James D	Evansville	Vanderburg.
Shea, James W	Wabash	Wabash.
Smith, A. R	Marion	Grant.
Smith, Craven	Delphi	Carroll.
Smith, Levi	Bloomington	Parke.
Smith, W. C	Indianapolis	Marion.
Smith, A. W	Kokomo	Howard.
Spencer, R. R	Clarksburg	Decatur.
Stradling, E. H	Muncie	Delaware.
Swain, A. A	Milroy	Rush.
Stearns, Rob't B	Lebanon	Boone.
Thompson, N. L	Crawfordsville	Montgomery.
Truitt, Wm	Muncie	Delaware.
Thrawls, Jas. C	Rensselaer	Jasper.
Van Buskirk, Jehu	Tipton	Tipton.
Vawter, Everett B	Lafayette	Tippecanoe.
Vatwer, P. C	Lafayette	Tippecanoe.
Wagoner, H. H	Huntington	Huntington.
Walls, R. H	Greencastle	Putnam.
Ward, H	South Bend	St. Joseph.

*Deceased.

LIST OF MEMBERS—Continued.

NAMES.	POSTOFFICE.	COUNTY.
Waugh, Jas. M	Crawfordsville	Montgomery.
Whitten, Wm. M	South Bend	St. Joseph.
Wiles, E. P	Hartford	Ohio.
Wiley, O. B	Ft. Wayne	Allen.
Williams, A. D	Anderson	Madison.
Wood, F. D	Seymour	Jackson.
Warren, Albert K	Lebanon	Boone.
Wright, James O	Lafayette	Tippecanoe.
Winslow, W. W	Indianapolis	Marion.
Younts, Wm. H	Fairfield	Franklin.

HONORARY MEMBERS.

NAMES.	POSTOFFICE.	STATE.
Billingsley, J. J. W.	Indianapolis	Indiana.
Beckmann, L	Toledo	Ohio.
Bergen, Samuel	Franklin	Indiana.
Dover, H. L	Philadelphia	Pennsylvania.
Elliott, W. P	Chicago	Illinois.
Finley, James A	Franklin	Indiana.
Gurley, L. E	Troy	New York.
Hodgman, Frank	Climax	Michigan.
Logan, S. H	Greensburg	Indiana.
Matheny, F. G.	Auburn	Indiana.
Randolph, T. F	Cincinnati	Ohio.
Sturgeon, Charles	Columbus	Ohio.
Watson, T. N	Philadelphia	Pennsylvania.
Young & Sons	Philadelphia	Pennsylvania.

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THE INDIANA ENGINEERING SOCIETY,

As a body, is not to be held accountable for any heretical or opinionated statements advanced in any of the papers published in this report; but as the Society is progressive, and as progress and development lie outside of the old ruts, in the open field—the field of investigation and experiment—it says to each one of its members, stand up and speak your piece, *success* in life depends on *action*; but the tubs must not be telescoped, for “*each tub must stand on its own bottom.*”

CONSTITUTION.

ARTICLE I.

THIS organization shall be known as the INDIANA ENGINEERING SOCIETY.

ARTICLE II.

ITS objects shall be the encouragement of professional improvement, and good fellowship among its members by annual meetings for the presentation and discussion of papers on such subjects as may be of interest to its members, and the collection of books, maps, and all other articles of value to the engineering profession.

ARTICLE III.

SECTION 1. Any practical Surveyor or Civil Engineer in good standing may become a member of this Society upon recommendation of the Executive Committee, and the payment of an initiation fee of \$3, and signing the Constitution and By-Laws.

SEC. 2. Any one interested in engineering improvement or scientific study may be elected an associate member by complying with Section 1 of this Article, and shall be entitled to all the privileges of members, except holding office and serving on committees.

ARTICLE IV.

SECTION 1. The officers of this Society shall consist of a President, Vice-President, Recording Secretary, Corresponding Secretary, Treasurer, and an Executive Committee of five members, two of whom shall be the President and Corresponding Secretary, *ex-officio*. They shall

hold office for one year, or until their successors are elected, as hereinafter provided.

SEC. 2. They shall be elected by ballot on the last day of each annual meeting, and their term of office shall begin immediately after the presentation of the annual reports of the Secretaries and Treasurer, at the beginning of the next annual meeting.

SEC. 3. The President, Vice-President, Secretaries and Treasurer shall perform the duties usually pertaining to their several offices, and whatever books, papers or any other property belonging to the Society they may have at the close of their official term, shall be delivered to their successors in office. The Recording Secretary may also be elected Treasurer.

SEC. 4. The Executive Committee shall audit the accounts of the Secretary and Treasurer, shall have a general care of the affairs of the Society, shall arrange the programme of exercises for each annual meeting, and announce the same on the last day of the annual meeting preceding the one at which such exercises are to be held.

SEC. 5. During each annual meeting the President shall appoint the following standing committees of three members each, whose duty it shall be during the year to collate such facts, figures, information or experiments of interest in their respective departments as may be brought to their notice, and make at least one formal report to the Society at the annual meeting following their appointment, viz:

Committee on Legislation.

Committee on Drainage.

Committee on Engineering and Surveying.

Committee on Public Highways and Bridges.

Committee on Instruments, Blanks and Records.

Committee on Statistics, of which the Corresponding Secretary shall be chairman, *ex-officio*.

SEC. 6. During each annual meeting the President shall appoint a committee of three, entitled, "Committee on National Public Works," whose duty it shall be, when requested to do so, to meet and act with similar committees from other societies similar to our own.

ARTICLE V.

THE Recording Secretary and two other members, to be appointed by the President at the beginning of each annual meeting, shall be a committee to compile and publish the annual report of the transactions of the Society. They shall include in this report all items in the proceedings of general interest; papers read before the Society (carefully revising when necessary), and such other matter as may seem to them advisable.

ARTICLE VI.

THIS Constitution may be amended at any annual meeting, by a two-thirds vote of the members present, but shall never be amended so as to be confined to the exclusive use and needs of any one branch of engineering.

BY-LAWS.

SECTION 1. The Society shall at each regular meeting select the time and place at which the next annual meeting shall be held.

SEC. 2. The Executive Committee shall provide a room for the meeting, and the Corresponding Secretary shall give twenty days' notice of said meeting to the members of the Society.

SEC. 3. Ten members shall constitute a quorum for the transaction of business.

SEC. 4. Each member shall pay an annual membership fee of two dollars and fifty cents.

SEC. 5. The Treasurer shall pay only such bills as are approved by the Executive Committee.

SEC. 6. The President shall have power to call an extra session when required by Executive Committee.

SEC. 7. A record of all donations to the Society, whether in money, books, maps, models or other articles, shall be entered by the Recording Secretary in a book provided for that purpose.

SEC. 8. The order of business shall be as follows:

1. Call to order.
2. Roll call.
3. Report of Recording Secretary.
4. Report of Corresponding Secretary.
5. Report of Treasurer.
6. New officers assume their duties.
7. Address by President.

8. Reports of committees.
9. Unfinished business.
10. New business.
11. Papers and discussions.
12. Election of new members.
13. Election of officers and miscellaneous business.
14. Programme.
15. Reading of minutes.
16. Adjournment.

SEC. 9. The Parliamentary authority for this Society shall be Cushing's Manual.

SEC. 10. The By-Laws may be amended at any annual meeting by a two-thirds vote of the members present.

REPORT OF THE ELEVENTH ANNUAL MEETING

OF THE

Indiana Engineering Society,

HELD AT

Indianapolis, January 20, 21 and 22, 1891.

SURVEYOR'S OFFICE, COURT HOUSE, }
INDIANAPOLIS, IND., January 20, 1891. }

The Society met in regular annual session at 2 o'clock P. M., being called to order by President Pulse.

The Recording Secretary called the roll, and fifteen members responded to their names, being more than the By-Laws require to constitute a quorum for the transaction of business. The Society therefore proceeded with the order of business, following the programme as nearly as possible, and making due allowance for the non-arrival of members from remote parts of the State.

The reading of the minutes of our last meeting was, upon motion, dispensed with, for the reason, that they were embodied in the published reports of the meeting.

Treasurer R. I. Morrison read his report, which, in compliance with the Constitution, was referred to the Executive Committee for auditing.

Recording Secretary J. R. Brown read his report, which, for the preceding reason, was also referred to the Executive Committee.

The Corresponding Secretary's report was called for, but he had not yet arrived in the city.

President Pulse, with a few appropriate remarks, retired, and introduced the incoming President, Robert I. Morrison, who made a very interesting and exhaustive address, reciting the great engineering projects of modern times. (See page 26.)

Mr. Pulse, of the Executive Committee, recommended Curtis G. H. Goss, of Martinsville, Morgan County, and A. W. Smith, of Kokomo, Howard County, for membership in our Society. They each paid the membership fee, \$3.00, signed the Constitution and By-Laws, and were duly taken in as members of the Society.

A recess was declared to give the members present an opportunity to pay their annual dues.

Prof. Norris moved that a committee be appointed to canvass the meeting to see who would be willing to make contributions, so that we could arrange our next programme, which, after some discussion, was withdrawn in favor of a motion by Mr. Pulse, that it was the sense of the meeting that the Executive Committee be instructed to canvass the meeting for the arrangement of a programme, which was concurred in.

Mr. Pulse now moved to adjourn until 7 o'clock P. M., which prevailed.

R. I. MORRISON,
President.

J. R. BROWN,
Recording Secretary.

EVENING SESSION, January 20, 1891.

The Society met pursuant to adjournment at 7 o'clock P. M., being called to order by President Morrison; and nothing special being before the meeting some one asked that chronic question, "How shall I survey and subdivide section six (6)?" As usual, the Government Instructions were given, and various opinions expressed as

to whether the instructions meant that the quarter section corners on the north and west sides should be just forty chains from the northeast and southwest section corners respectively, or whether they should be located proportionately in accordance with the excess or deficiency between the Government chaining as marked, and what it proves to be when the County Surveyor is called on to subdivide said section and applies *his unit* of measurement; which may be an "old chain" very much too long by wear in its 600 points of contact applied by a *practical* "old timer," whose unerring aim, some old settlers would say, could always "hit the corner right plumb in the middle," in running a needle line with the old Jacob Staff compass, and who would swear himself that his chain was *just right*; or the latest improved steel tape adjusted and graduated according to the Government standard, applied by the man in the more advanced stage of development, who keeps up with the times and mixes theory and practice, just owing to what stage of evolution he may be in at the time. In the discussion the old scabs were picked off, and the question was, for the time being, an open sore again.

From the general drift or direction of thought in the discussion, the majority inclined to the opinion that whatever the Government chaining is marked is what it should be made and must be taken for the standard or *unit of measure*; that is, if there is any excess or deficiency according to your measurement, you must adjust yours to that of the Government marking, calling each chain just so much longer or so much shorter, or in other words you must apportion the excess or deficiency.

Mr. Cheney, who was on the programme for a paper on "Substructure for Bridges," not having anything prepared, made a short extemporary address on said subject,

after which an interchange of opinion was indulged in by the members present.

The meeting, on motion, adjourned until to-morrow morning at 9 o'clock.

ROBERT I. MORRISON,
President.

J. R. BROWN,
Recording Secretary.

MORNING SESSION, January 21, 1891.

The Society met at 9 o'clock A. M., pursuant to adjournment, being called to order by President Morrison.

The Recording Secretary read the minutes of yesterday's meetings, which, on motion, were approved.

The reports of standing committees were called for in their order.

Prof. J. Norris, of the Executive Committee, Wm. M. Whitten, of the Legislative Committee, and J. R. Brown, of the Committee on Instruments and Blanks, made brief oral reports.

When the reports of the Committees on Drainage, on Engineering and Surveying, and on Public Highways and Bridges were called for, there were no responses, as none of the members of said committees were present.

G. M. Cheney, chairman of the Committee on Statistics, made a brief oral report, stating that he had gathered no statistics during the year that he thought worth while to report.

R. I. Morrison, chairman of the Committee on National Public Works, also reported orally, mentioning the principal important works of the country.

J. R. Brown, chairman of the Printing Committee, read his report, with reference to the printing of the proceedings of the last annual meeting.

Jacob Norris, Professor of Mathematics and Civil Engineering in Wabash College, read an exhaustive paper on "Water Works Plants," which was very interesting and caused a general discussion to follow.

Mr. Alter offered the following preamble and resolution, to-wit:

WHEREAS, The next World's Fair is to be held in the city of Chicago, which is so close to the State line of Indiana that we feel proud to have the Columbian Exposition so near us; and,

WHEREAS, The engineering societies of other States are taking steps to show up the progress and present status of the profession;

Resolved, That we appoint a committee of three to correspond and co-operate with the committees of other engineering societies in regard to the engineers' and surveyors' part in the great exhibit, and report their proceedings at our next annual meeting.

The resolution was concurred in, and L. S. Alter, W. M. Whitten and Prof. Jacob Norris were appointed a committee to act in compliance with the resolution.

On motion the Society adjourned until 2 o'clock P. M.

R. I. MORRISON,
President.

J. R. BROWN,
Recording Secretary.

AFTERNOON SESSION, January 21, 1891.

The Society met pursuant to adjournment at 2 o'clock P. M., with President Morrison in the chair.

J. T. Campbell, on the subject of "Irrigation in Indiana," not being able to be present, forwarded his paper to H. B. Fatout, who read the same before the Society. Discussion followed.

R. I. Morrison, not having anything prepared on the subject of "River and Harbor Improvements," outside of what he embodied in his address as President, gave a

general description of Bonanza Dyke, which is being constructed in the Ohio River, and of which he is the United States Superintending Engineer, with headquarters at Portsmouth, Ohio.

R. H. Walls, who was on the programme for a paper on "Street Pavements," was not present at the meeting, and the subject was passed over.

W. P. Carmichael, on the subject of "Aluminium," stated that he had not prepared any paper that he could read on that subject, as the metal had just lately come into some prominence, and had not yet been brought into general practical use on account of the great expense heretofore connected with the manufacturing thereof.

L. S. Alter, who was to read a paper on "Kankakee Drainage," stated that he had not written anything on the subject, and that he came here more for the purpose of hearing and learning something about it from those who had been connected with the proposed drainage than of informing others of its practical utility. He gave a short talk on the subject in the way of a bait, but most of the members seemed to be afraid to venture out into the still, deep waters of that "dismal swamp," and the practical utility of the "Kankakee Drainage" still remains an unsolved mystery.

Mr. Carmichael introduced the following resolution, to-wit:

Resolved, That Article I, of the Constitution, be amended to read as follows:

This organization shall be known as THE INDIANA ENGINEERING SOCIETY.

The resolution was, on motion, for the time being, laid on the table.

Craven Smith, who was on the programme for a paper on "Superstructure of Bridges," not having anything prepared to read, opened an oral discussion upon the

subject, which was participated in by the members present, but more particularly by Messrs. Smith, W. M. Whitten and A. E. Phillips, Professor of Civil Engineering in Purdue University.

Mr. Phillips, on motion, was requested to prepare a paper on that subject for our report of 1892.

There being nothing special before the Society, the subject of "Tile Drainage," and especially the tiling of the heads of formerly constructed open drains was discussed, and the conclusions were that the head waters should always be tiled as far down stream as practicable, and that it was beneficial to crops to construct tile drains even on slopes and rather elevated portions of farm lands.

Mr. W. A. Osmer, who was to read a paper on "City Sewerage," was unable to attend the meeting, and the subject was called up by Prof. Norris, and generally discussed by the members, so far as their knowledge and experience extended.

Prof. Norris presented the following resolution, to-wit:

"Resolved, That a committee of five be appointed, whose duty it shall be to devise means by which a greater interest may be aroused in this Society, and by which it may become more progressive."

The resolution was concurred in and Prof. Jacob Norris, L. S. Alter, W. M. Whitten, M. H. Downey and J. F. O'Brien were appointed a committee to act in accordance with the spirit of the resolution.

Corresponding Secretary G. M. Cheney read his report for the past year.

The Society, on motion, adjourned until 7 o'clock P. M.

R. I. MORRISON,
President.

J. R. BROWN,
Recording Secretary.

EVENING SESSION, January 21, 1891.

The Society met pursuant to adjournment at 7 o'clock P. M.

J. F. O'Brien read his paper on "Land Partition," in which he took the position that the County Surveyor should be *ex officio* one of the commissioners in all cases where lands are partitioned through the courts in order that accurate descriptions might be given for all the tracts set off in the cases. A general discussion followed.

H. B. Fatout, read a paper on "City Surveying," after which a general discussion was indulged in by the members present.

L. S. Alter, introduced Senator T. E. Howard, of St. Joseph County, and Senator — Jones, of Marshall County, who attended our meeting expecting to get some information on the subject of drainage.

Senator Howard addressed the meeting on the subject, stating what they were after and asked the members to discuss the subject with them as to what legislation was needed for public utility as well as for the enhancement of private interests in the construction of proper drains.

The members present gave in their experience with the legislation of the past up to the present time, stated the defects of existing laws, and made suggestions as to what changes ought to be made in the future legislation on that subject.

On motion, the Society adjourned until to-morrow morning at 9 o'clock.

R. I. MORRISON,
President.

J. R. BROWN,
Recording Secretary.

MORNING SESSION, January 22, 1891.

The Society was called to order pursuant to adjournment, at 9 o'clock A. M., President Morrison presiding.

J. R. Brown read a paper on "Natural Gas Plants."

Prof. Norris introduced the following resolution, to-wit:

Resolved, That the Indiana Society of Civil Engineers and Surveyors, deeming it very important that their great State should be creditably represented at the coming Columbian Exposition, do recommend that the Legislature now in session appropriate at least two hundred thousand dollars for this purpose.

The resolution prevailed.

The resolution of Mr. Carmichael with reference to the changing of the name of our Society to the Indiana Engineering Society, which was tabled yesterday afternoon, was taken off the table and adopted by more than a two-thirds vote.

Mr. McCarter offered the following resolution, to-wit:

"Resolved, That Section 1 of the By-Laws be amended to read as follows: Section 1. The Society shall at each regular annual meeting select the time and place at which the next annual meeting shall be held."

The resolution making our Society, for the present at least, a sort of a migratory institution was concurred in; upon which an overflow of courtesy, welling up from deep fountains of local pride, exhibited itself and took form in numerous invitations to meet in the favored cities containing the homes of some of our worthy members; and following the numerous invitations and discussions as to which place would be the most suitable, a vote was taken, which upon the third ballot resulted in the selection of Lafayette as the place for the holding of our next annual meeting.

On a motion, which prevailed, the time for the holding of our next annual meeting was fixed to begin the second Tuesday in January, 1892, at 2 o'clock P. M.

On motion, which was concurred in, the Society entered upon the election of officers for the ensuing year. The election resulted as follows; to-wit:

- President, Prof. Jacob Norris, Crawfordsville, Montgomery County.
- Vice-President, J. F. O'Brien, Cloverdale, Putnam County.
- Recording Secretary, W. P. Carmichael, State Line, Warren County.
- Corresponding Secretary, E. B. Vawter, Lafayette, Tippecanoe County.

Treasurer, H. B. Fatout, Indianapolis, Marion County.

EXECUTIVE COMMITTEE—Jacob Norris and E. B. Vawter, *ex officio*, and Prof. A. E. Phillips, W. M. Whitten and W. W. Clogston.

President Morrison appointed the following standing committees, in accordance with our constitution, to-wit:

Legislation.

- JACOB NORRIS Crawfordsville.
- L. S. ALTER. Remington.
- M. H. DOWNEY Rushville.

Drainage.

- L. S. ALTER. Remington.
- W. M. WHITTEN. South Bend.
- CRAVEN SMITH. Delphi.

Engineering and Surveying.

- H. B. FATOUT. Indianapolis.
- CURTIS G. H. GOSS. Martinsville.
- J. C. PULSE. Greensburg.

Public Highways and Bridges.

- W. M. WHITTEN. South Bend.
- J. R. BROWN. Frankfort.
- THOS. FINLEY Shelbyville.

Instruments and Blanks.

- GEO. M. CHENEY. Logansport.
- JAS. L. ROMACK Tipton.
- A. T. S. KIST Warsaw.

Statistics.

J. F. O'BRIEN	Cloverdale.
A. W. SMITH	Kokomo.
R. H. WALLS	Greencastle.

Printing Reports.

J. R. BROWN	Frankfort.
R. A. HOWARD	Richmond.
JACOB NORRIS	Crawfordsville.

The Recording Secretary was instructed to notify all committees at least thirty days before our next meeting that they were expected to make written reports.

President Morrison made a brief statement of the financial condition of the Society, and the balance due the *poor* printers, and the following generous-hearted members contributed the sum of \$13.75 toward making up the deficiency: Messrs. Goss, Carmichael, Morrison, Norris, Whitten, Vawter, Clogston, O'Brien, Fatout, Smith and Brown.

On motion, which prevailed, the Society adjourned *sine die*.

R. I. MORRISON,
President.

J. R. BROWN,
Recording Secretary.

RECORDING SECRETARY'S REPORT.

To the Officers and Members of the Indiana Society of Civil Engineers and Surveyors:

GENTLEMEN: Your Recording Secretary respectfully reports that the minutes of our proceedings and papers read at the last annual meeting of the Indiana Society of Civil Engineers and Surveyors were arranged

and edited for publication as early as possible; but were not printed until in July, on account of some delays caused by returning some of the papers to their authors for revision and correction, so as to appear in creditable shape in print, and a fire in the office of Mr. Cheney, at Logansport, where we had the material for our reports, and were at work preparing the same. The committee rejected some of the papers on account of them simply rehashing old theories, advancing nothing new, and being "dished up" in such defective grammar and punctuation that we shrank from the task of re-writing, and, with a sigh of relief, laid them aside.

It is no easy task, in preparing a report for publication, to have to look over and correct a lot of papers, wherein a few constipated ideas are lost in a deluge of words without punctuation or proper grammatical construction.

Most of the papers read and presented were in very good shape, and each one reading a paper before the Society, if it is *not in good shape* for publication at the time, should revise the same, or have some one do it for him, before sending it to the Printing Committee; as it should not be the duty of the committee to *re-write*, but to *select* and arrange the material for the reports.

I received a communication from S. P. Langley, Secretary of the Smithsonian Institution at Washington, D. C., stating that said Institution was desirous of obtaining the publications of our Society regularly, in exchange for their annual reports. I will read the communication before adjournment for your action.

During our work of arranging the material for publication, we solicited and procured advertisements amounting to \$160, to be inserted in our reports. We also received propositions for the publication of two thousand copies of reports, and awarded the contract to Wilson & Humphreys, of Logansport, at \$1.30 per page, they being the lowest bidders.

After the reports were printed, they were left in the hands of the Corresponding Secretary for distribution among our members and the exchange lists of sister societies.

During the last meeting I received for annual dues and membership fees the sum of \$48, which I paid over to Treasurer Morrison.

Respectfully submitted,

J. R. BROWN,
Recording Secretary.

TREASURER'S REPORT.

Robert I. Morrison, Treasurer, in account with the Indiana Society of Civil Engineers and Surveyors :

RECEIPTS.

January 23, 1890.

To balance on hand	\$33 84
To cash from Secretary Brown	48 00
To cash from advertisers	160 00
Total	<u>\$241 84</u>

DISBURSEMENTS.

January 23, 1890.

Paid G. M. Cheney, Corresponding Secretary . . .	\$22 85
Paid L. S. Alter	9 00
Paid Wilson & Humphreys	\$110 00
Paid Wilson & Humphreys	50 00
Paid Wilson & Humphreys	15 00
Paid Wilson & Humphreys	20 00
	<u>195 00</u>
Paid expressage, postage and exchange	16 73
Total	<u><u>\$243 58</u></u>

SUMMARY.

January 23, 1890.

Balance due Treasurer from Society	\$1 74
Am't due Wilson & Humphreys, as per bill. \$260 00	
Am't paid Wilson & Humphreys, as above	195 00
Balance due Wilson & Humphreys	<u>65 00</u>
Total amount due from the Society	<u>\$66 74</u>

Respectfully submitted,

ROBERT I. MORRISON,
Treasurer.

CORRESPONDING SECRETARY'S REPORT.

RECEIPTS.

From J. C. Pulse	\$2 50
From R. R. Spencer	2 50
From John O'Conner	1 00
From J. H. Brennon	2 50
From Wm. O'Brien	2 50
From Hiram Burner	3 00
Total	<u>\$14 00</u>

EXPENDITURES.

For expressage on Provincial Land Surveyors' Reports.	\$4 95
For expressage on Dominion Land Surveyors' Reports.	4 65
For expressage on Ohio Reports	2 00
For expressage on Michigan Reports	2 20
For expressage on books to Indianapolis	3 00
For printing circulars	1 25
For printing programmes	4 25
For postage	2 00
Total	<u>24 30</u>
Balance due Corresponding Secretary	\$10 30

Respectfully submitted,

GEO. M. CHENEY,
Corresponding Secretary.

ADDRESS OF THE PRESIDENT.

GENTLEMEN:—It is a pleasant duty to welcome you as members of the Indiana Society of Civil Engineers and Surveyors to participate in the proceedings of our Eleventh Annual Meeting. The grand object of our Society, as set forth in its constitution, is the encouragement of professional improvement, and, with the above object in view, I shall detain you but a few moments from labors which promise to be of unusual interest.

On the 2d and 3d of March, 1881, our first meeting was held, and the Society then organized has held its regular annual meeting ever

since. It was not largely attended, but I now see the faces of a few who were with us in the outset, and who have been regular attendants at almost every meeting the Society has held. I have a copy of our First Annual Report. It contains the names of but twenty-seven members. The report was a small affair of but sixteen pages, three of which were all that were required for the proceedings; the Constitution and By-Laws took two pages, the list of members one page. An opinion of the Attorney-General was the only paper it contained. The only advertiser was our worthy friend, the instrument maker, Beckmann. The Society has been steadily growing since that time. The papers published have also grown in number and in interest. The patronage of our advertisers affords us the means to publish our reports. We have exchanges with sister societies of several States, as well as two societies in Canada. The many valuable papers on surveying and engineering subjects published in these reports well repays the slight tax upon our pockets in keeping up our membership dues, for we receive an equivalent of more than ten times its value in publications of scientific and professional interest.

The Surveyor or Engineer in Indiana who does not meet us here is standing in his own light, and possibly missing something which might be of great professional interest and advantage to him. To say the least, he loses the opportunity of interchange of views with his fellow-workers, he fails to keep up with the times by not receiving the publications of the Engineering Societies, and he fails to contribute his small mite toward their circulation and distribution.

There are always some grand and bold undertakings being worked out by the Engineers. In this address I can but barely mention a few now in progress.

THE TUNNEL UNDER THE HUDSON.

The great tunnel under the Hudson River, in New York City, by the use of new methods of applying compressed air, and by the aid of electric light, which does not vitiate the air, is progressing rapidly, with a safety to life and comfort of the workers unknown before. Its length is 5,644 feet. It is circular in shape, with a diameter of 20 feet in the clear, and it is thought that it will be completed in 1892. It is 80 feet below the surface of the water. An interesting account of this work has just been published. It will be found in Mrs. Frank Leslie's Monthly for next month (February, 1891). One-half of the distance under the river has already been reached.

THE GRAND BRIDGE OVER THE HUDSON.

Engineer Thomas C. Clark, in November last, submitted the plans, estimates of cost, proposed sites for the ends, plans of its approaches, its span, and a drawing of its magnificent Union Depot on Broadway. It is almost ready for the work to begin, but the projectors, owing to the unfinished business relating to the purchase of property, have deemed it inadvisable to make public the site chosen at the outset. It is estimated that it can be completed, approaches, depots and all, in three years. The work will begin in March next. The cost will be \$50,000,000, and there is little doubt that bonds for the entire amount can be easily placed. It will be a suspension bridge, with eight railway tracks, with an elevation in the center of 155 feet above the water. The span will be over half a mile long. Preliminary plans have already been submitted to the War Department to show the height above the river. The New Jersey approach will be arranged so that all Northern New Jersey railways can connect with the bridge tracks, running into them on an easy grade of 31 feet to the mile. There will be run electric street cars, also, for the accommodation of residents of Jersey City and Hoboken. The depot, near Forty-second Street and Broadway, is to be the largest and finest in the world, and will be the terminus of all the great railways entering New York.

THE JEDDO TUNNEL

Will be a grand undertaking in anthracite coal mining enterprise. It is about to be begun in Pennsylvania, and will be constructed from Butler Valley to the bottom of Ebersole Mammoth Vein, a distance of three miles. The tunnel will be eight feet square in the clear. It pierces solid rock through its whole extent, and will open not only an almost inexhaustible supply of coal, but will furnish perfect drainage for all the coal mines of the valley.

A HARBOR TO BE DREDGED OUT.

The Government is soon to begin the construction of a harbor in the Delaware River, between Philadelphia and Camden. It will require an enormous amount of excavation, and will be one of the greatest works of the world. Two islands are to be removed from the river—Windmill Island, containing seventeen acres, and Smith Island, containing eight acres. The excavation will amount to 17,000,000 cubic yards.

Factories, stores, shops and dwellings will be demolished, and the ground they occupy will be removed to make a deep water harbor. The contract has been let, and the work is to be finished in three years.

A SHIP CANAL ACROSS NEW JERSEY.

There is another great work recently projected in Philadelphia. As "smart as a Philadelphia lawyer," is an old saying. There is no particular use to apply an expression like that to their Engineers, for they are expected to be smart, but from the way they are just now pushing forward with grand undertakings the lawyers will have to look out or the Engineers will crowd them off the seat, and the old expression about the lawyers be forgotten. There is now on foot a project to construct a ship canal across New Jersey from the Delaware River to the Atlantic. It will make a shorter route for shipping, save some hundreds of miles journey down the bay and around the cape to strike the steamers' route to Europe. There is little question that, in the near future, the canal will be built.

HYDRAULIC TUNNEL AT NIAGARA.

Thomas Evershed, Division Engineer of the New York State canals, has originated and perfected the plans for a subterranean tunnel extending from the surface of the river below the falls to a point on the Niagara River above the falls and out of the way of the reservation. It is connected with the river by means of short surface canals, wheel-pits and cross-tunnels. It is nearly two miles in length and will be cut through solid rock at an average depth of 160 feet below ground. The contract has been made and the work already commenced by the Cataract Construction Company, the members of which are well known leading financiers of New York. The first section of the work is to be completed and the power ready for use by January 1, 1892. The projected plan will develop 120,000 horse power. The wheel-pits, conduits and connections being cut through solid rock, insure stability and a small cost for maintenance. The Engineers constructing the work are Albert H. Porter, John Bogart, Coleman Sellars and Clemens Herchel.

In this connection an inquiry is likely to be made as to the effect on the falls of the diversion of the water necessary for this great enterprise. To one who has seen the great volume of water ever pouring over the falls, one such canal or a hundred such would be thought too small to make a perceptible difference, but even this has been calculated by the Engineers. Mr. Bogart, in an opinion given to the Commissioners of

the State reservation, December 8th ultimo, stated that the diversion of water through the proposed tunnel would have no appreciable effect on the volume of water passing over the American falls. Two hundred and seventy thousand cubic feet of water pass over every second. The point of diversion is 1.36 miles above the falls and the capacity of the tunnel 10,000 feet. In every three feet of fall there will be a reduction of 1.3 inches, if the tunnel runs full, or less than half an inch on every foot.

THE CHICAGO SHIP CANAL.

L. E. Cooley was Chief Engineer of the Chicago Drainage Commission until about the middle of December ultimo. His report was made public on the 30th of December. He holds that a channel twenty feet in depth and 600 feet wide will actually cost less than the eight-foot depth and small width that the Federal Government has been partly undertaking.

The reason given by him is that an easier grade would be taken by the larger channel, and this grade, by the peculiar conformation of the route, would render unnecessary much otherwise expensive cutting through solid rock. He says there is also an erroneous impression that the possible navigable depth of the Mississippi is small. The ultimate attainable depths from Lake Michigan to the Gulf are limited only by the supply of water which can be drawn from the lakes with a certain measurable supply. The report condemns as destructive to existing commerce any attempt to make the Calumet River, instead of the Chicago River, the connecting link between the ship canal and Lake Michigan. He is opposed to the idea of a lake front harbor at Chicago except for the purposes of refuge. In place of the lake front he places the practically unlimited dockage of the Chicago and Desplaines Rivers and the proposed ship canal, with additional outlets to the lake through the heart of the city at Thirty-ninth street, and also near Grosse Point. He thinks that by depositing excavated material on the lake front a thousand or more acres of immensely valuable land would be created, the income of which would, in the end, relieve Chicago of all taxation for the great waterway.

The commercial importance of the project as a whole he treats in this wise: "If deep water existed to-day from the Hudson via the great lakes to New Orleans, a vessel could complete the circuit by gulf and Atlantic seaboard, and touch at cities which contain 60 per cent. of the urban population of the United States. Such a coast line through the productive heart of the continent is worthy of all the time and all the resources that may be needed."

The Associated Press report, dated December 30th ultimo, of Mr. Cooley's project is, in substance, as given above.

The reasons why the Government should build the greater part of it were forcibly and entertainingly given by Judge Richard Prendergast in his inaugural address as President of the Chicago Ship Canal Trustees, delivered January 3d inst. I beg leave to quote a part of his address. He spoke in part as follows:

"It was stipulated by Great Britain and the United States in the treaty of 1817, that both nations should be restricted to three war vessels on the great lakes, and by the terms of the treaty these were to be of the kind and armament as then known, the armament being on each vessel one eighteen-pounder brass cannon, such as was known at that time. "When the treaty was made the great lakes and the vast territories tributary to them were a mighty wilderness. Now the lakes are bordered with regions of dense population, and mighty cities are all along their shores. The British-Canadian authorities at an expenditure of more than \$200,000,000 have constructed a series of waterways between the lakes and the Atlantic seaboard, of such dimensions that over one hundred and twenty-five war vessels on the British naval list can pass from the British naval station, at Halifax, into the great lakes, and in addition, it has been the policy of that government to foster the construction of steel vessels for commercial purposes, to navigate the Canadian waters, susceptible of use as armed cruisers in case of hostilities.

"On the northwest corner of our country is Puget Sound, and there on Vancouver Island, commanding that sound as completely as the Rock of Gibraltar commands the entrance to the Mediterranean, is another British military and naval station, remarkable among other things for having planted on the fortifications there the largest gun ever sent out from the establishment of Krupp. So that not to speak of British military and naval stations that circle our country in others, such as the West Indies, and Belle Isle territory, and the islands of the Pacific, we have upon our northern frontier a rich, strong and vigorous country and people, bound by many ties to England, presenting all along our borders a magnificent military system, offensive and defensive, and up to this hour the government of the United States has done substantially nothing to meet or cope with a hostile descent from this source. It is true that the defenseless condition of the northern frontier has been presented to Congress from time to time, but with very little results, if any. May not this disproportion existing between the preparations for war on the one hand and those on the other account for the results of the diplomatic correspondence between the two countries, of which America would appear to have no special reason to be proud?"

Continuing, Judge Prendergast said the Federal Government has surveyed Lake Peoria, which is but a widening of the Illinois River opposite and near the city of Peoria, and its naval experts and departments have pronounced it an adequate and valuable site for a government station for the construction, maneuvering and storing of torpedo gunboats. Indeed, most of the investigations and expenditures made by the Federal Government in the Illinois River have had relation to the subject of ultimately perfecting accessibility from the Mississippi to Lake Michigan. If such a station had existed at Lake Peoria at the breaking out of the civil war, it is the opinion of those competent to judge that the backbone of the rebellion would have been broken a year or two earlier than it was. But of course such a station would be an absurdity in so far as it relates to the lakes, without a channel for the passage of vessels from it to the lakes, and there is no doubt that the construction of the main channel, aided by the logic of the situation and of events, will compel the construction of the remainder of the waterway by the Federal Government with, among other things, the construction of such a naval station near the city of Peoria.

The address of Judge Prendergast, being in fine print, has taken a longer time to read than I had expected, but it is so full of interest throughout that I know you will not begrudge the time it has taken.

When it comes to big enterprises there is not much danger that Chicago will not spread herself to be in the lead, and now that the stimulus of the great Quadro-centennial Fair is upon her, some wonderful achievements may be looked for. Here is an account of a tower that will be planned after the ancient

TOWER OF BABEL.

A reproduction of the famous Tower of Babel as it stood in the great city of Babylon, three thousand years ago, will be a feature of the World's Fair in Chicago. The Smithsonian Institution is to supply the model, which will be constructed under the supervision of Dr. Haupt, the distinguished oriental scholar, and upon his plans. Erected on precisely the scale of the celebrated original, it will ascend in seven diminishing stories, impressive from without, while its interior will be a museum exhibiting life and affairs as they were in the mighty empire of ancient Assyria, with the most remarkable assemblage ever got together of art works, books and all sorts of other curiosities dug out of the vast mounds, which now are all that remain of Babylon and Nineveh. Already a Washington architect has completed the plan and elevation of the model, ten feet in height, which will soon be in readiness for shipping

to the Exposition, where it has but to be copied by enlargement. Final action on this matter has not yet been taken by the management of the Fair, but there is understood to be no doubt that the scheme as above outlined will be carried out.

The intention is to construct the building not of bricks, like the original tower, inasmuch as that would be too costly, but of iron and according to the best methods of modern engineering. One disadvantage of ancient Babylonian architecture was that it was particularly unstable. The houses, palaces and temples, however magnificent and expensively built, being made of sun-dried brick, with burned bricks only for facing; always tumbled down within at most a century. Such was the fate of the Tower of Babel itself, though it was rebuilt at least once by Nebuchadnezzar. The city of Babylon, which had 2,000,000 inhabitants and covered about twice the area of London, stood upon an immense plain of clay very suitable for bricks, and there was no stone of any sort to be had. Myriads of slaves, toiling under merciless drivers, built the astonishing public works executed by the Kings of Babylonia, just as was the case with the pyramids of Egypt.

Of all these works the most celebrated was the chief among the many superb temples of Babylon, the ruins of which have been designated by modern archaeologists as those of the Tower of Babel. Although not more than 140 feet high, it seemed to the dwellers of the great Assyrian plain, where there were no lofty objects for comparison, to nearly touch the heavens, and it was said that the tongues of men were confused in attempting to describe its wonders. Its actual height was considerably added to in effect by the fact that it was built, like all other important Babylonian edifices, upon a high artificial terrace. Still further was it uplifted by a second platform of earth 600 feet square. From this upper platform the tower arose, its first story 272 feet square and twenty-six feet high, faced with glazed brick painted black in honor of Saturn. To Jupiter the second story was dedicated, and the color belonging to that god being orange, it was of that tint—220 feet on a side and twenty-six feet high. The color of the third story was red, in compliment of Mars; each of its four sides was 184 feet and its height twenty-six feet. Each of the last four stories was fifteen feet high. The fourth story was 148 feet square and covered with thick plates of gold, being dedicated to the sun. White was the hue of the fifth story, out of respect for Venus, and it was 112 feet square. The sixth story was blue, Mercury's color, and each of its sides measured seventy-six feet. A cube of fifteen feet formed the seventh story, covered with plates of silver, in honor of the moon. These dimensions and colors are

given all wrong, according to Professor Haupt, in a recently published Babylonian novel called the "Master of the Magicians." He thinks that there was on the top of the seventh story some sort of cupola or observatory for astronomical work, but this is not certain. The tower at the Fair will have to have windows of the ordinary sort, though one thing which Assyriologists of to-day have not been able to ascertain at all is how the buildings of Babylon were lighted. Such, at all events, was the Tower of Babel, considered the greatest architectural marvel of its age, stored inside with golden statues and other treasures of inestimable value. From this type of structure the Egyptian pyramid was originally developed by simply filling in the slant between the stories so as to make each side a smooth descent instead of a series of steps."

Since there seems to be much uncertainty, according to Prof. Haupt (who naively declares every one else at fault), it will be entirely safe to depend upon it that the Chicago engineers will put in the best efforts of their lively imaginations and create a building that will far surpass the original world wonder.

MICHIGAN CITY WATER PIPES EXPOSED.

Last month there was a storm on Lake Michigan, the surprising thing about which was that, as the Associated Press report puts it: "It develops that although Michigan City has expensive water-works, a mistake was made in placing the feed pipes in the harbor in such a position that when there is a high wind from a certain quarter the water is forced out of the harbor and the pipes are high and dry. During the greater part of last Saturday and Saturday night, while a heavy gale was blowing, the city was without fire protection."

It was hardly a mistake. It is more likely that the engineers had never seen nor heard of the bottom showing up in that way. It was an entirely unexpected condition of things. The skill of the engineer will not be found wanting in providing a remedy. The pipes can be sunk lower and a reservoir be dredged out and walled up of sufficient capacity to furnish the needful water supply, in case the harbor was in danger of being left "high and dry" by frequent repetitions of such phenomenal storms. It is probable, however, that the water came back in a few hours at most, and that the inconvenience was too unlikely to happen again to justify the expense of such an improvement.

BIG DAM IN INDIA.

The defective water-works of Bombay, India, are being supplemented by a dam two miles long, 118 feet in height, designed to enclose the water-shed which drains into the sea south of Bombay. It is being constructed by a Scotch engineer. The roadway on the top is to be twenty-four feet wide. The stone work will cost half a million sterling, equal to two and a half million dollars. It is expected to complete it by March next.

NAVIGATION OF THE AIR,

As a method of commercial transportation, has long been dreamed of by enthusiasts. The Mount Carmel man with his air-ship of aluminum, may get started sometime. If the Keely motor man would only make his machine go he might put it in the Mount Carmel man's ship, and both go on a trip to glory. I am free to confess that I never expect to live long enough to see the successful flying machine.

THE NICARAGUAN CANAL.

On the 5th instant a secret session of the Senate was held at the instance of Senator Sherman. It was learned that it was for the purpose of enabling the Committee on Foreign Relations to make a report relative to the Canal Company's affairs, and to secure from the Senate permission to make public certain matters of official information about the work. It is reported that new treaties have been negotiated, and that the success of the great enterprise is very promising. It is an American enterprise, and can scarcely fail to be a success.

INDIANA'S ALUMINUM INTERESTS.

A company has recently been formed and is already in operation in Martin County, for the production of aluminum, which it is claimed can be cheaply produced from the clay found there. It is almost as hard as steel and is the lightest metal known. The Mount Carmel man proposes to build his air-ship of it, Gurley thinks of using it in the construction of transits, and ship-builders are dreaming of its possibilities in marine architecture. It is known to be brittle, to possess but little ductility and no way has yet been found to temper it. My own faith in the wonderful cheapness with which it can be produced is very weak, nor would I care to trust myself in a ship made of it, until assured

that it can be made to take on some element of temper, by which its egg-shell brittleness could be compensated. Experimenters are at work with it, however, and it is too new a metal as yet to be condemned before its properties have been fully investigated.

SUSPENDED ELECTRIC CAR.

A model of an electric rapid transit railway is now on exhibition at the rooms of R. Clarke Forsyth, in Chicago. The car is hung from the elevated cable, which will be stretched over towers built at every street crossing or on blocks of unusual size, wherever necessary. Two T-beams will be suspended from the cable, on top of which will be placed an ordinary small steel-rail. The cars will be thirty feet in length, seven feet wide and eight feet high. There will be no platforms on the outside of the cars and the doors will be opened and shut by the conductor. The power-cars are to be fitted with two twenty-horse power electric motors, with a capacity for drawing five trailers. The other details it is not necessary to mention, except that it is so arranged as to make track-jumping an impossibility. Visitors to the World's Fair will probably be able to enjoy the pleasure of being whirled through the air at the rate of a mile a minute.

ELECTRIC ROAD FOR LETTER-BOXES.

In South America an electric road between Buenos Ayres and Montevideo, 186 miles long, is now about to be opened. It crosses the mouth of the LaPlata, where it is nineteen miles wide, and two wires from which the letter-boxes are to be suspended, are supported by a tower on each side 270 feet high. It is not designed to carry anything but letter-boxes. For rapid transit it will probably surpass everything yet devised in the way of overland carriage.

THE ASTOR HOTEL BUILDING IN NEW YORK

Will be 225 feet high and will have seventeen stories. The ground has lately been broken for it, at the corner of Fifth Avenue and Fifty-ninth Street. The excavation to a solid rock foundation ranges from twenty-two to forty feet.

CONCLUSION.

Who is there to predict the wonderful feats of engineering which may be accomplished during the next century? "What will the world be like a hundred years hence?" is the caption of a two-column article in the Indianapolis *Evening News* a week or two ago, by Mrs. Frank Leslie. She imagines that such marine wonders as the steamship "City of Rome" will excite mirth a hundred years from now on account of being so far behind the ocean racers then in service. We are now moving too rapidly in our strides of progress to be ready to admit that we have yet reached the acme of our speed. The Engineer is still at work! It will not be surprising if he shall continue to be accomplishing wonders in surmounting or in removing obstacles to progress and in devising better methods of propulsion over land and sea.

I thank you for your attention and will remark in conclusion that if the legal barriers and the railway opposition can be removed, it will not be a very difficult task to remove the Momence Rock, and the almost incalculable benefits of the drainage of the Kankakee marshes will be the greatest boon to our northern counties now in sight. I trust we may, during this session, be entertained by discussions looking to that great end.

WATER-WORKS PLANTS.

BY PROF. JACOB NORRIS, OF WABASH COLLEGE.

THE necessity for an artificial supply of water was realized a very long time ago. The ordinary supply from springs, streams, rainfall, at times gave out. Drouth besieged the country, and people could not trust the springs. Extraordinary demands of caravans were felt. The first well that we hear of, and the first artificial supply of water, was Jacob's well at Shechem. It was nine feet in diameter, and a hundred and five feet deep, cut entirely through hard limestone rock, and one traveler says, when he saw it, two hundred and fifty years ago, it contained, fifteen feet of water. It is now usually dry, and filled with stones and rubbish. It was circular, and had a very smooth surface. There was another famous well at Cairo, in Egypt, which was nearly three times as deep as this in Palestine, and its construction has excited

the interest and admiration of all engineers. The age and builders of this well are matters of conjecture. It was also cut through solid rock, and was divided into two separate compartments, large enough for oxen to work in, at a depth of a hundred and sixty-five feet below the surface. There is a spiral passage from the surface down to this second shaft, of such dimensions and of such gradual inclination, that persons ride up and down upon asses. The oxen, working in the chamber between the two shafts, raised the water into a reservoir at the bottom of the upper shaft, through which it was again raised to the surface by another windlass, worked by oxen at the top.

There is another celebrated well at Mecca, whose building has been attributed to Abraham and Isaac. Artesian wells are found in the desert of Thebes, the oldest city of the world.

We may remark with regard to these water-works of antiquity, that they show that those ancient people, driven by necessity, were no mean engineers according to their light, and that they must have invented some useful and ingenious machinery.

It is to be remarked also, that they held their wells most valuable property, and to use the water without paying for its use was as much a matter of theft as it is to-day. To possess a well was noticed as a mark of independence, and to abstain from the use of wells belonging to others, a disclaimer of interference with their property. Similar rights of possession, actual and hereditary, exist among the Arabs of the present day. Wells in the interior of the desert are exclusive property, either of the whole tribe or of individuals whose ancestors dug the wells. There has been many a battle at these ancient wells. Thus we see that water-works companies were, at a very remote period, justified in prosecuting individuals and companies for using water on the sly.

Another necessity, calling for an artificial supply of water, arose from the inadequacy of wells to supply the wants of increasing population which abounded in cities and towns. Hence we find the aqueduct at a very early period. I may not go amiss to detain you in giving a swift notice of some famous reservoirs.

There exist to-day traces of great canals in Egypt, where, doubtless the waters of the Nile, in times of flood, were stored. These great works of antiquity were not less wonderful, and far more useful, than their pyramids and monoliths. The Egyptians conveyed the water to the summit of a high hill, where immense cisterns were hewn in the solid rock to receive it, whence it flowed into the deserts below, converting them into fertile fields.

The famous aqueducts near Jerusalem and Tyre are said to have been built by Solomon, a thousand years before Christ.

Prior to the construction of the first aqueduct at Rome the people derived their supply from the Tiber, and from wells and springs, but they must have had machinery other than steam to pump it. The first Roman aqueduct was built about three hundred years before Christ, and brought the water from a distance of eleven miles.

One Roman aqueduct, built a hundred years later, was thirty-eight miles long, about the same as the famous Croton aqueduct.

Another aqueduct, built later, was formed thirty-six miles under ground, and had three miles of tunnel. One writer has computed the supply of water for Rome, containing about one million souls at this time, at three hundred and twelve gallons for each individual, a consumption unequaled in modern times except in New York City. Instead of numerous factories, Rome had many public baths. Much of their tunneling was due to the fact that cast iron pipes were not then known. Some of the Roman aqueducts were remarkable for being built in tiers, one above the other, and several of those which supplied Rome brought in the water in separate streams, and at different levels, one over the other.

We also have traces of enormous water-works in Spain and Italy and South America, and it would seem as if, two thousand years ago, as much skill and expense were displayed in their construction as in this enlightened nineteenth century.

Dismissing these very ancient works, let me say, in passing from Egypt to America, that in England and France, and I suppose other modern European countries, the water supply is also obtained from wells and rivers. One well at Paris is said to be eighteen hundred feet deep, and another at Kissengen, in Bavaria, deeper still. In addition to the supply for the city of London, from the New river, hundreds of private wells are dug, among them, one by the bank of England, and many by the different breweries of the city. All of our best pumping and boring machinery had its birth in England, the home of the great Stephenson, and many other engineers, whose names will live as long as time lasts. The Liverpool water supply is furnished by an aqueduct about seventy-five miles long, much of it being pipe line.

Prior to 1800, not over six water-works plants were built in the United States. It is supposed that the first was in operation at Bethlehem, Pa., in 1762. In 1874 the works were rebuilt. The source of supply has always been springs. New York City was first supplied in 1799, and the mains were bored logs. Morristown, N. J., had water-works in 1799. Portsmouth, N. H., dates hers back to 1797. Those at Durham, Conn., were built in 1798. Four of these works get their supply from springs. I am unable to say whence the supply for New York City came.

The aqueduct at Boston was first built in 1796. She had mains built of pitch-pine logs of four-inch bore. The distribution pipes were also wood.

Since 1800 there have been built nearly two thousand water-works, and so far as I know, not one has been completely abandoned unless it has been replaced by one of greater capacity. These works have been maintained principally because they have proved valuable investments, both directly and indirectly. The income has probably paid a fair interest on the money expended, after deducting all operating expenses, and it is likely to be better yet. We must confess however, that it is a very difficult thing to get at the facts concerning income. Many works have been poorly and inadequately constructed, built to sell again as speculating schemes, and in a few years, everything must be rebuilt. This will not be so much the case in the future, for those who furnish the money for the bonds are employing expert engineers to examine every piece of work.

The incidental advantages of water-works cannot be estimated in figures. If they do not become absolutely necessary, they approximate nearer to it than any other modern luxury, and I think that those who are enterprising enough to invest their money in this business should receive very great consideration from the public, and instead of being classed by them among the monopoly sharks, they should place them on their catalogue of friends.

A few towns have duplicate water-works plants. Several plants in Maine, Rhode Island and New Jersey take in two or three villages. The water-works mains in the United States aggregate about thirty-five thousand miles, enough to go once and a half around the earth. The greatest percentage of increase in the United States was from 1850 to 1880. In the South there were no plants erected from 1859 to 1870. In the Northwest not a single plant was erected till 1867, and none in the Southwest until 1871, but within the last few years these sections, hitherto neglected, have had far the greatest per cent. of increase. Perhaps the best place for an enterprising young engineer is in the South and Southwest. Everything, at least in a material point of view, is reconstructing. In Colorado, and the Rocky Mountain districts, the overflow from the irrigating plants supplies the smaller towns with running water.

The rapid rate at which water-works have sprung up within the last twenty years, especially in Pennsylvania and New York, is mainly due to the enterprise of Mr. Holly, of Lockport, N. Y. He furnished a type of machinery by which water could be pumped directly into the mains without the use of the reservoir or tank, and with any desired pressure, converting the whole plant, if necessary, into a fire engine.

Other pump builders began to compete with this pioneer, and, of course, the result has been very beneficial to the country in producing improved machinery and many new ideas. Many young men have turned their attention from other branches of civil engineering to that of hydraulics. As a consequence, numerous experiments have been tried, and much useful literature has appeared from time to time, mainly in the reports of water-works conventions. There are several financial associations, mostly in New York City, which are ready to furnish the necessary funds to carry out any enterprise which may promise to be profitable. Encouraged by this substantial support, many plants have been constructed by private capital. At present about 55 per cent. of water-works are owned by private parties. In some States the ownership is almost wholly public. Of new works more are held by private parties, still far less than other monopolies. Out of thirteen hundred electric light plants, about seventy-five only are owned by the public, and only six gas-works are so owned. Held by the public: Gas-works, $\frac{1}{4}$ per cent.; electric light-works, 6 per cent.; water-works, 45 per cent. There is a difference of opinion as to whether the public is served as well and as economically by private companies as by municipal control. Mr. Fanning, in his most valuable treatise on water supply, says: "If the works, when complete, were operated under municipal control, their standard and effectiveness would more certainly be maintained; their extension into new territory might keep pace, and encourage the growth of the city; they might not, by excessive rates, be made to oppress more important industries; their advantages might more surely be kept within the reach of the poorer classes; they might more economically be applied to the adornment of the public buildings and grounds; and they might, when judiciously planned, constructed and managed, become a source of public revenue." He then adds: "Nearly all the objects desirable to be attained in a public water supply have, however, been accomplished in numerous instances that might be cited under the auspices of private enterprises." Many men of sound judgment fail to see how, with fair and honest treatment, a private corporation is in any way inferior to city ownership, and in the conduct of its works, it is often superior, especially if the city officials are corrupt.

Inasmuch as we have alluded to some of the more important aqueducts of the ancients, it may not be irrelevant to give a passing notice to the most imposing aqueduct of the present generation. I refer to the new Croton aqueduct, which is capable of supplying about one million and a half barrels of water daily. The first Croton was begun in 1837, and finished in five years. The new one was started in 1884, and was five years also in building. The total reserve at the disposal of New

York City will be, when all the proposed dams shall have been completed, sufficient to last for several years of drouths, being from all sources, according to Mr. Charles Barnard, about seven thousand million gallons, a reserve unequalled in all times, so far as I know. This is seventy times as much as that of Philadelphia, and its daily consumption is only two times as great as New York's. This amount of water would fill a reservoir with a base as large as this State House (Indiana State House) square, and about six miles in the air. The water shed of the Croton works is about three hundred and sixty square miles. For elaborate descriptions of the Croton works, see articles in the *Century*, December, 1889; *Harpers' Weekly*, December 14, 1889; and *The Engineering News*, volume 21, page 444. How much this aqueduct really cost is probably not known, but this is known, that several million dollars were paid out for work that never was performed, and that was certified to have been performed by those appointed to watch the work.

But this enterprise seems minute, in comparison with one projected several years ago. It was proposed to bring the supply from the upper Adirondacks, a distance of two hundred and seventy-five miles, and on its way down to the city, it would supply all the towns in the Hudson River Valley. It was estimated that it would cost sixty million dollars.

Here is another scheme: It was proposed to water the city of Chicago by an aqueduct from Lake Superior, a distance of four hundred and fifty miles off, and on its way to the city, it would supply the wants of many smaller cities. Chicago thus would obtain an inexhaustible supply of the purest water, instead of being compelled to pump it from the great lake, into which its sewerage is poured. Neither of these designs, to my mind, seem impractical dreams, and may be, some time in the future, realized.

So far as our own State is concerned, she is not behind other States in water-works, there being fifty or more, and several projected, which will probably be in operation before 1892. The following cities and towns have water-works: Anderson, Attica, Bluffton, Brazil, Columbus, Connersville, Crawfordsville, Elkhart, Evansville, Ft. Wayne, Frankfort, Goshen, Greencastle, Greensburgh, Hammond, Indianapolis, Jeffersonville, Kendallville, Kokomo, Lafayette, Laporte, Ligonier, Logansport, Madison, Marion, Michigan City, Mishawaka, Mount Vernon, Muncie, New Albany, New Carlisle, New Castle, Peru, Plymouth, Richmond, Rockport, Salem, Shelbyville, Seymour, South Bend, Terre Haute, Union City, Valparaiso, Vincennes, Wabash, Warsaw, Washington, Wolcottville.

The most pretentious of these works is in Indianapolis, and they are said to be the most efficient direct pressure works in the United States.

They were first built in 1870 by a private company. The water was taken from White River. In 1879 a large crib filled with stone was sunk in the river and acted as a filter. The works were rebuilt in 1889, and at present Indianapolis has seventy-eight miles of water mains, and some of these are nearly two feet in diameter. The works are operated by an improved Holly engine. I find, by a comparison of water rates, that Indianapolis has lower rates than the average American city. The supply at present is from driven wells, which flow into a large, oblong gallery, and thence the water is pumped into the mains. Natural gas is used to generate the steam, and costs \$600 a year for each boiler. The grounds surrounding the works are beautiful, and the pump house is neatly finished, and adorned with flowers. In connection with the engine, there is an automatic machine, regulating the supply of both steam and water at will. There is also a device automatically registering the pressure at each moment, and the record is placed on file. Whenever there is a fire alarm this instrument will tell how much pressure was turned on, thus officially settling all disputes. It will also disclose the fact of any serious leak or waste of water. It seems to me that all the machinery of these works is of the most improved type, new and most excellent.

I will close this paper by giving a brief notice of the water-works in Crawfordsville. These works were built in 1886, with a twenty years' franchise from the city. The supply is from what are known as the Van Cleave Springs, which have a capacity of double the ordinary wants of the city. The streams from these springs are impounded by a dam, and the water is discharged into a circular reservoir eighty-seven feet in diameter, and twelve feet deep, and thence pumped directly into the mains, and also into a tank. This tank is also circular, fifteen feet in diameter, one hundred and seventy-five feet high, and made of riveted boiler iron. A careless calculation tells me that the weight of the water in this tank is nearly one thousand tons, equal to that of the Niagara suspension bridge. The plant is run under a greater expense than most works, from the fact that the springs are about sixty feet below the level of the city. A pressure of one hundred pounds is required. The reserve water, in case of drouth, is sufficient to last several weeks by using great economy. As to the actual cost of the plant, I can determine nothing definitely, as the works are, at present, in litigation. I do not think, however, that they could be built for less than \$75,000, that is, about \$6,000 per mile of pipe. Nor do I know what the operating expenses are; but I do not believe, that after the interest on the bonds is paid, much of an income is in reserve. I know this much, however, that no greater boon ever came to Crawfordsville, for it brings to our doors the

best water on earth. Our great fault, in common with all cities, is that we waste as much as we use, the daily consumption being 250,000 gallons or a large wagon load every minute. Of course this consumption includes factories, public hydrants and fire service. It is estimated that in New York and other large cities only ten per cent. of the water consumed is used for drinking and culinary purposes, but I think that a much larger per cent. than this would be used in smaller towns.

IRRIGATION IN INDIANA.

BY CAPTAIN J. T. CAMPBELL.

Irrigate, from Latin *irrigō*, *in* and *rigo*, to water.

Many crops have been lost in the Wabash valley which would have been saved if there had been a good rain at the middle of the drouth that lost us the crop. As we can not yet produce a rain at any time that may suit our wants, we may mitigate the bad effects of a drouth at a cost far below the benefits that will result.

About ten years ago I thought of the practicability of irrigation in this country and I have, while going about my regular work, studied the topography, with a view to that end. I at first thought of a grand sprinkler, such as one of our large city fire engines would be, but later experience and observation taught me that such a work would greatly waste water for next to no good. Water sprinkled on very dry ground at night, greatly increases vegetable thirst next day. The rootlets and suckers of vegetables, during the temporary wetting, build toward the moisture, only to be baked by the hot sun, soon to follow. An artificial moisture, to be effective, must be moderate in quantity, continuous in supply and free from rapid evaporation.

On nearly every field in this country is an elevation on which an artificial pond or reservoir can be cheaply constructed, that will hold from 3,000 to 5,000 barrels of water. A reservoir four rods square and four feet deep will hold over 1,000 barrels. It will require 550 yards of embankment and can be built on contract for \$65. Larger ones can be built much cheaper, in proportion to the water capacity.

Suppose a reservoir to have a capacity of 4,000 barrels. From an estimate furnished me by Frank L. Dougherty, late chief engineer of

the Indianapolis fire department, a force pump can be run by one of our ordinary portable engines, that will throw 300 gallons per minute, or 4,050 barrels in nine hours. Such a reservoir can be filled in one day, including setting and unsetting, at a cost not exceeding \$15, if it had to be put in on contract. One such engine and pump can do the work of five square miles, by beginning a little in advance of the drouth.

The water from the reservoir can be let off into small, deep, narrow trenches to various parts of the field, after the manner of irrigation in the dry West. A better plan, and one more economical when once prepared, would be to run the water into small tile, leading off from a main at about right angles and on nearly a dead level, following the contour of the field. These can easily have cut-offs arranged to regulate the flow of water.

WHERE IS THE WATER TO COME FROM?

Before answering this question I will say that a drouth in this country seldom lasts over three weeks. But often during that three weeks the crops and the work of a year are lost. Two years out of three, at least, the seasons will be such as to require no irrigation and for the third year often one flow of water will tide us through the drouth. Therefore but little water will be required. To obtain that little, I find, in looking over the country, that there is scarcely a field of twenty acres but has the head of a small brook convenient to it, which, by damming, can be made to hold from 5,000 to 50,000 barrels of water. From these the water can be forced to the elevated reservoir as before described.

WILL IT SUCCEED IN CARRYING THE CROP THROUGH A DROUTH?

In reply, I will observe that it does succeed in the dry West all the year round. Why not here during a short drouth?

WILL IT PAY?

Yes. When we have favorable seasons our corn yields forty to sixty bushels per acre, some fields much more. I know of two upland clay fields in Penn Township, Parke County, where, a few years ago, in one the corn yield was ninety bushels, and in the other and adjoining field, the yield was fifteen bushels per acre, difference due to cultivation. I also know of another small piece of ground in the near vicinity of the before mentioned fields, about one-tenth of an acre, which yielded at the rate of 150 bushels of corn per acre. It was a lot where chickens had

been confined. The ground was broken, the corn sowed and harrowed in. It came up as thick as grass, and the owner with a plow cut out the major part, leaving rows between the furrows, with one stalk to about six inches of breadth each. It had no other cultivation. It soon so shaded the ground that the summer drouth that prevailed elsewhere was not felt there. The ears were very short, very thick and well filled. During the year 1875, the great flood year here, the only corn we raised was on the hillsides, where during an ordinary year the yield was poor, and of a dry year nothing; but that year it was the best yield I ever saw on any ground. I mention these cases to show the power of our soil to produce when the conditions are favorable. With irrigation we may, to a great extent, produce the conditions which are favorable to production.

NOT AN EXPERIMENT.

Irrigation is not an untried experiment, it is indeed no longer an experiment. It is one of the oldest works of man. The greatest work of the kind antedates Solomon's Temple. This was made to irrigate the valley of Moreb, in Yemeh, Arabia. It was a dam two miles long and 120 feet high; was built of huge blocks of stone, and did service 2,000 years. It broke at last, and devastated a great district of country.

My judgment is that when we shall be prepared for irrigation on the plan I have given, we shall not need it one year in ten. Why do I say this? Because, to irrigate as I propose, each quarter section of land must have three to five acres of pond water. If this were to-day the case all over the State, we should have very little drouth. There might be periods of several weeks duration in which there might be no rainfall; but we should have a humid atmosphere, which would give forth a bountiful dew every night, which would feed vegetation and carry it prosperously through the non-raining period.

DRY AIR AND WATER.

It is very remarkable with what rapidity a dry air will drink up water. In the room which I occupy in the Court House for my office are two large steam heaters. Their combined length of pipe is 504 feet, which multiplied by the circumference of the pipe gives 198 square feet of radiating surface.

The room has 7,560 cubic feet of space. This gives 38 cubic feet of air for each square foot of heating surface of the pipes. When my window sash gets stuck fast, as they have been of late, the air becomes

so dry that all the ink in my stand is evaporated every day. When full it holds $1\frac{1}{8}$ cubic inches of ink. I was obliged to fill it every day when the cold snap caused us to turn on full heat.

In the latter part of August, or early September, 1863, I was notifying the enrolling officers of some order from the Provost Marshal, which caused me to make a trip that took me by every mill-dam on Raccoon creek, in Parke County, from Portland Mills to Armiesburg, seven in number and the distance about twenty-five miles. The streams were then fed by the springs alone. At Portland Mills I happened to notice the clear sheet of water pouring over the mill-dam and it reminded me of hearing, when a boy, the engineers who superintended building the Wabash and Erie canal, say that although Raccoon appeared to be as large a stream as Sugar Creek, the latter flowed nearly twice as much water as the former. I wondered how they ascertained the quantity of flow, and made a rude mental calculation of the quantity that was then flowing over the dam there. I mention this circumstance to show that I took particular notice of the water flow. At McClarey's Mill, south of Hollenburg, six miles below Portland Mills, I noticed that the flow did not seem so great as at Portland Mills. At Mansfield, two and one-half miles further down, I felt confident that the quantity of flow had decreased, notwithstanding Rocky Fork and several other creeks had been added. At Bridgeton, four miles further down the creek, it was still more apparent. Roseville, seven miles further down, showed an apparent increase over Bridgeton, as it should, for the Little Raccoon had been added. But it appeared to be less than at Portland Mills. At Mecca, five and a half miles more, the decrease was very noticeable, and at Armiesburg, three miles farther down, notwithstanding the addition of Leatherwood, it was very noticeable that it was less than the flow at Portland Mills, about twenty-eight miles above, by the stream. The dry, still air had absorbed the water of Raccoon creek faster than the springs had fed it. If it had a channel fifty miles longer the water would have been entirely evaporated before it reached the mouth. Well, as "figures won't lie," (but those who use them often do), if the volume of water flow increased up stream at the rate I have intimated, how much larger should the flow be at the very head, where it bubbled up out of the first crawfish hole, than at Portland Mills?

The answer is, that probably at a point fifteen miles above Portland Mills there was as great a water flow as at Portland Mills, or probably greater. But, as we travel up stream, the ratio of the volume of the tributaries to the main stream greatly increase, and every time a side branch is lopped off, the main trunk is more and more diminished. Besides this, the channels grow narrower, and the foliage on their banks

shade them more, and their sand bars grow smaller. Thus two great evaporating powers are greatly diminished. Otter Creek and Lost Creek, in Vigo County, go dry several miles above their mouths, for the reasons I have before given. When the air becomes moist, the streams rise, because evaporation ceases.

This water, evaporated by the air, if kept in the vicinity where it is evaporated, as it very generally is during a drouth, for there is very little wind-blow at such times, will be given back to vegetation in the form of dew, provided that in the night the air can be cooled sufficiently; for a warm air will carry much more moisture than a cold one. A degree of moisture in the air which would be carried easily during the day, will be dropped as dew in the night on a certain degree of cooling.

WATER ON EACH QUARTER SECTION.

Suppose we had to-day a five-acre pond of water on each quarter section of land in the State, as we might easily have, you can see plainly that we should have a much more humid atmosphere, and having this, we should have much less destructive drouths, if any at all, even though there should be no actual rainfall.

The fish which the ponds will support will alone pay the cost of the pond.

A CASE IN POINT.

I cite a case in support of what I say of the beneficial effect of numerous ponds on vegetation. During the exhausting drouth of 1881 the middle and south parts of our State were dried to a crisp. The crop reports for that year by counties show a falling off of about fifty per cent. in the corn crop in the central and southern parts. But up in the north end of the State, where the small lakelets are numerous, though there was little, if any, more rainfall among the lakes than in the dry belt, the crops suffered but little from the drouth.

I was in the Indiana Bureau of Statistics then, and helped make up those reports, and hence especially remember the circumstance. I inquired of people why such good crop reports came from certain northern counties, as there was no rainfall reported from them more than elsewhere, and the presence of the numerous small lakes was given as the reason.

LAND PARTITION.

BY J. F. O'BRIEN.

Mr. President and Gentlemen of the Indiana Engineering Society:

The subject assigned me is one of considerable importance, and one about which it will be very difficult to furnish a paper that will contain anything new, interesting or edifying, since it is, notwithstanding its importance, a very prosaic subject. It is one, however, with which the land surveyor has often to contend. Ever since the time the laws of primogeniture have begun to be condemned as unjust the distribution of estates has become more common.

Lands may be held in four different ways: In severalty, in joint-tenancy, in co-parcenary and in common; but, for our purpose, however, it will not be necessary to enter into a detailed discussion of how the title in each case is acquired, but suffice it to say that lands held in joint tenancy, in co-parcenary, in common, or in severalty, it is often desirable for the co-tenants to terminate their property relations with one another, and thus avoid irritation that must necessarily attend an association compelled by interest, but repulsive by every other consideration. Co-tenants, no longer content to hold their property in common, may, if it is susceptible of division, have it transformed into estates in severalty.

A partition may be either voluntary or compulsory. It is voluntary when accomplished by the co-tenants by mutual agreement among themselves, and it is compulsory when effected by a decree issued by a court having competent jurisdiction for that purpose, acting at the instance of one or more of the joint-tenants. Formerly there were four methods by which voluntary partition was made. First, the co-parceners, by a direct agreement among themselves, made the partition, and each relinquished his title to the others' allotments, and each took his parcel in severalty. This method is much used in this country yet. By the second method the co-parceners first select some mutual friends, usually three, to divide the lands into equal parts according to valuation, and each one selects a share to be held in severalty, the selection usually being made in the order of seniority.

The third method is where the oldest heir makes the division, and is the last to make the selection of a share, or, in other words, takes what is left after the others have selected their shares.

The fourth method was where there were four parceners, and after the lands were allotted, the parcels were numbered to correspond to numbers placed upon slips of paper; then each slip of paper was rolled up in little balls of wax and put into a hat held in the hands of a disinterested person, and then the eldest took out the first ball, the second the second ball, and so on till all the balls were taken out, it being understood that each one was to keep the share drawn, whether it suited him best or not.

The partition of lands by lot is the most simple, as well as the most impartial method that can be employed. It is likely, also, to prove a most satisfactory method, because it leaves all the parties without any apparent evidence of fraud or partiality. It is a method as old, perhaps, as the history of the world, for we read in the book of Numbers that when Moses, on the plains of Moab, had numbered the Children of Israel, the Lord spake unto him, saying: "Unto these the land shall be divided by lot; according to the lot shall the possession thereof be divided between the many and the few."

In case of voluntary partition by arbitration, where commissioners or co-heirs make the allotments of the *lands*, it must not be inferred that they also partition the *title*, for each co-tenant must convey and release, by deed, to the others his right and title to the parcels severally allotted to them.

With any of the above methods of partition the surveyor may be connected. He will, doubtless, be called upon to make surveys of the different parcels of land allotted, for the double purpose of setting off the desired quantity of land, and to make a suitable description to enter into the deed of conveyance.

Compulsory partition is the method of partition in which the court may issue a writ of partition, upon the petition of one or more of the co-tenants, and appoint commissioners to make the division. It would be foreign to the scope of this short paper to enter into a detailed discussion of the laws governing courts having jurisdiction to try partition causes. We will therefore direct our attention to the commissioners appointed to make the partition, their duties and report to the court. The warrant of partition issued to the commissioners, usually three disinterested persons, whose kinship should be no nearer than the fourth remove of the ties of consanguinity from the co-tenants, sets forth the names of the co-heirs, and the share to which each, by law, is entitled to have set off to him. The commissioners have no power to determine questions of title; but they have a right to correct any faulty description that may be found in the warrant purporting to describe the lands which they are to divide.

“When a judgment of partition has been decreed,” says Freeman, “it is a conclusive determination of the rights and title of all the parties to the proceedings, and no question any longer remains open concerning their ownership or title of their undivided shares and interests.” The commissioners have no other duty to perform, or authority to act, than to divide the estate according to the directions contained in the warrant.

The statutes provide that commissioners shall be sworn before they enter upon the discharge of their duties, and also to give notice of the time and place where they will meet to make partition. They are also authorized to employ a surveyor, when they deem it necessary, and to divide the lands in such a manner as to give each co-tenant, as nearly as possible, his proper proportion in value of said lands.

In some instances the lands are divided into equal shares, and it is then determined by lot to whom each part shall be assigned, but it is better to distribute the shares without having recourse to chance, for it often happens that shares can be allotted so as to make them more valuable and desirable to certain heirs, by having them adjoining other lands already owned by said certain heirs, or certain heirs may desire that their shares may adjoin each other.

The commissioners, under certain conditions, have a right to award to certain heirs an owelty of partition, where they are unable to make an equal distribution of the estate. When an owelty is awarded it must be shown in the report of the commissioners, and when it is confirmed by the Court it becomes as a judgment against the share against which it has been awarded. It is held by some authorities that an owelty of partition can not be made without the expressed permission of the Court issuing the writ of partition, but in this county (Putnam) it is the custom to make an owelty of partition only when the consent of the interested parties is obtained. Our statutes provide that when the commissioners find, upon a close and careful examination, that the estate is not susceptible of division, without too great injury to any or all the co-tenants, they may report against the partition and recommend the Court to order the premises sold. In the determination of the question as to whether a sale should be advised, or an actual division made, the commissioners meet with many difficulties. They must examine the property, and if from such examination they conclude that a sale is preferable to partition, they must so report to the Court, giving a statement of the facts and reasons upon which their conclusions are based.

The true question to be answered by the commissioners seems to be as to whether the whole property will be greatly injured or diminished

in value, if separated into parts and held in possession by different persons according to their several rights and interests in the whole, or in other words, as to whether the sum of the values of the several parts, held in severalty, would be greatly less than the value of the property as a whole.

The next thing that will be considered in this paper is the report of the Commissioners. They, or a majority of them, must make a written report of their proceedings to the Court appointing them, and if they have made a division of the lands, they must show to whom each parcel is allotted, and each parcel should be accurately described by metes and bounds, and each description should be complete within itself. It should not begin at the N. E. corner of A's lot, and run to the S. E. corner of B's lot, but each parcel should be described with reference to some prominent landmark in the vicinity.

When an easement is made against any share or shares, it should be accurately described by metes and bounds, to all of which should be added a complete plat of the estate divided.

Let it be observed here that a practical land surveyor should be made a member of every committee appointed to make partition of an estate. The reason for this last observation is self-evident, for when any trouble arises concerning the description of any land, and after all other sources of information have been exhausted—even the country Justice has been consulted (half of whom should be banished to Siberia, and should be compelled to wear their shoes filled with cockle burs for the rest of their lives as a partial atonement for their blunders), and the long-tongued lawyer tried and counseled, and the learned Judge has adjusted his judicial spectacles and examined the case with great gravity, and all failed—the meek and modest surveyor is called upon, and the difficulty disappears before his penetrating gaze as a misty fog before the morning sun. Then, since he has been found a necessary factor at last in unraveling the blunders of others, why not make him so at first, in preventing those poor, deluded people from undertaking to do that which they do not understand, by making him chairman of every committee appointed to make partition and put him under a \$5,000 bond, and make him responsible for any mistake he may make in description of lands?

In conclusion, the Legislative Committee is earnestly solicited to use their best endeavors to secure the passage of an act making the County Surveyor *ex-officio* Commissioner of Partition, and fixing his bond at \$5,000, and making him responsible on his bond for all his errors.

CITY SURVEYING.

BY HERVEY B. FATOUT.

This will be the second time I have dealt out to the Society substantially the above named article of food, and by the time I shall have finished this *hash*, I doubt not that the Society, and particularly the committee that appointed me on this subject, will decide that a change of diet will greatly benefit the members.

These two words, "City Surveying," look very simple; the majority of people call them simple; the young surveyor jumps into the business considering them simple, and in fact they are plainer at the beginning than they are later on.

Just think of the number of people who build their houses and make their fences without a survey. Frequently I am called upon to stake a lot in the older additions, and I find but few people who had their lots surveyed before they made any improvements.

Of course the spaces are irregular, and the last man who builds, generally has a shortage in his lot.

The carpenter used to say that he could save that expense and could do it just as well as the surveyor, and I must admit that some carpenters are careful and do good work, and that some surveyors are careless and do poor work.

Sometimes the carpenter will measure across eight or ten lots from some fence supposed to be on the line. His measure will be a ten-foot pole or clothes line, which is worse than a pole, and, though honest he may be, we can readily see that he is liable to stop at the wrong place.

Other parties make improvements in the same way and all is well till some one finds a shortage and calls in a surveyor.

If you wish to see self-importance, independence and boldness, take a view of a young surveyor who has swallowed the theory of surveying, perhaps has graduated and is almost ready to say that the old surveyors don't know much. I was once a young surveyor and while I did not have any thing to say against the old surveyors, I considered myself well qualified and fully equipped to survey any lot, or solve any problem.

I had handled the instrument, and had made many calculations, but the first time I was sent out by myself I came pretty nearly getting stuck. I ran against a problem that I had never heard of in theory, and it looked plain, too. It was this: A man wished to build a fence on a straight line, both ends of which were known, and only a few

stakes were needed. Oh, yes! I could do it, and went to the place in the eastern part of the city; but I then discovered that the center of the line was about twenty or twenty-five feet higher than either end, and I had to set the instrument on top of the hill to see both ways. To help things along, the old rail fence-row, as is usually the case, was well filled with bushes, and I, of course, thought the instrument had to be exactly on the line, so I had a line cut through the bushes, pointed the telescope toward one corner, turned the telescope over, and could not hit the other corner. I moved the instrument, cut a new line, moved the instrument again, cut another line, and it took me nearly a half day to run that short line, and it was about the hardest half day's work that I ever did, especially the mental worry part. I went out bold as a lion, came back meek as a lamb.

That survey was so indelibly printed on my mind that twenty years have not erased it from my memory. Theory is all right; but for practical work the theoretical surveyor is a failure till he gets his theory and practice well mixed. One place where the above assertion will particularly apply is in city surveying. We see such diverse interests, and so many different problems, so different that in hardly any two problems will the application of the same rules apply. These problems are more difficult where the older land surveys have been loosely made.

We do not expect to find the accuracy so great in land surveys as we do in city work; but, when a land owner wishes to make a city, and his land was poorly surveyed and poorly described, the case is not made any better by getting the same kind of a surveyor to lay out the city. He will make bad measurements, or leave off some distance, or follow some old, bad description, so that there will be endless trouble for all time to come.

I do not claim that an experienced surveyor will never make a mistake, for he is only human, and I do not believe the man has ever lived who never made a mistake. The experienced surveyor is less liable to make mistakes, and is more liable to do good work. I think the coming surveyor is the one who will first study the theory, then go in with an older surveyor as assistant, and mix his theory with practice. When he gets his theory mixed with practice, I think he is qualified for the office of County Surveyor, and I think the time not far distant that, before the County Surveyor can get a commission, he will have to show a certificate which he received after passing some kind of an examination.

The people are becoming more particular than they used to be; many of the carpenters now want stakes set before they commence the building, and some of the architects, in their estimates of costs, include an item "Survey of lot."

Abstracters, also, are more particular in their business. In making an abstract of title, if they come across a lot that is liable to touch a poorly described tract, they advise the owner to get a surveyor who will furnish an accurate description upon which the abstracter can make the abstract.

Lawyers, too, call upon the surveyor more frequently than in former times. It used to be that a lawyer would make his own descriptions, and in partition suits would appoint three farmers to make the division, and then he would write the report, descriptions included.

The majority of the lawyers now ask for a surveyor in partition suits, and in the most of the cases they will take his descriptions as he makes them; but in all cases I keep a letter-press copy of the descriptions I write and of the plats I make, so that, in case of a change, I can easily tell who made the change.

A short time ago I was called upon to survey some property adjoining the town of New Bethel, in this county. It commenced at the south-east corner of a house yard-fence and ran to a county road, thence to two oak trees, etc.—not a distance given, not a bearing given. Several town lots were sold off, and from this same beginning point. The original deed was made in 1835, so that the house yard-fence is no more, the county road has been vacated, and the oak trees, including the stumps, are not to be found. The owners of the lots sold off have had possession the requisite length of time to give them a title, and the remaining lot, as inclosed, had eight sides and was in two sections.

I finally made a survey of the inclosed lot, giving distances and bearings, and a definite beginning point, and wrote the deed accordingly. The purchaser submitted this deed to his lawyer, who decided it good.

I speak so much about descriptions because the survey and description are inseparable, and the first thing I want when called upon to make a survey, is the description. Here in Indianapolis, in some out-lots, the lots were sold by metes and bounds, and the record looks all right.

In one case the owner was, according to my understanding, a very well educated man, a fair lawyer and a Judge. Whenever he had a purchaser he would take him to the lot, take a certain number of steps and spit, and where the spit would land, drive the stakes and give the man possession of a lot according to these measurements. The Judge knew from the out-lot just how many feet he owned and made his descriptions accordingly. His descriptions are fair, and the records look all right, but when the surveyor undertakes to place his steel line measure over the stepping and spitting measure they will not agree; sometimes the steps were too long, and sometimes too short. The owners have had peaceable possession for more than twenty years, and our courts

have decided that in such a case the owner is entitled to that lot, no difference how incorrectly it was fenced or how incorrectly the old measurements were made. That decision is all right, as it simply bears out the old instruction to the surveyor to find, if possible, where the Government corner was actually located, and not where it should have been. When a surveyor comes across a lot of this kind, he needs a plentiful supply of sound judgment, fully as much as he does accurate measurement. Sooner or later, here in Indianapolis, we will have law-suit after law-suit over the boundary question, and in those suits the lawyer will pay his respects to the surveyor for the careless way in which he made his surveys. In some cases the surveyor has been mostly to blame, as he has seen fit to keep off the record much that should be there. He may have kept private maps in hopes that they might become valuable at some future day.

Irvington was laid out with beautiful curved drives; but not very many surveyors like to do surveying in that town. Very few curves have the radi given on the recorded plat; the length of the curve is not given; the length of tangent not given, and many of the cross-lines not given. Very few fronts of lots are given. Now it strikes me that if a surveyor undertakes to survey one of those lots he is liable to meet with great difficulties.

Of course, if the owners are satisfied for him to guess at the curves, all will be well until the lots become of great value, and then some one will think a portion of his lot is inside the inclosure of his neighbor. A law-suit will ensue, and, if this should happen in the lifetime of the surveyor who made the original survey, he will very likely be called into court to prove something.

If that surveyor has kept all those distances and radii, he may have hard work to convince everybody that he did not manufacture them for that particular case; but if he does succeed in convincing everybody that he has the correct distances, etc., I believe he will be liable to receive a pretty sharp lecture from court and lawyers for not putting those notes on record.

A lady came to my office last week to see about a lot in Irvington that she thought of buying, and the front is not given, and the owner was going to deed her the south part of a lot. I advised her not to accept that kind of a description, as it was too indefinite.

I believe the Legislature could help the future cities very much by making just one little law in regard to plats. The plat should be plain, give bearings of lines, or the different angles the different streets make with each other; the size of all the lots should be plainly marked on the plat, so that any one looking at the plat could see the size of each and

every lot on the plat. Also, permanent monuments should be placed at each corner of the subdivision, and at the intersection of each street crossing in the subdivision. The location of these monuments should be shown on the plat, with the distances, one from another, and all the angles at intersection of different lines. With this plat to be recorded should be a description sufficient that when the plat is filed for record the Recorder can go to the county and city map and properly locate that subdivision without any uncertainties whatever.

In order to compel the above things to be done, the Recorder should have power to reject any or all plats that fail to fill the bill, and in order to compel the Recorder to examine the plats, he should be under a penalty of double the fee he received for the plat, in case the plat was not correct, and he did receive it.

If the above is done the little town will be all right, and when the town turns to city the city will be all right. There should also be a penalty attached for moving any of the monuments. At this time there is in my office a plat of a town not many miles from Indianapolis—it was left there for my draughtsman to make a map of the town. It seems that there has been some trouble with reference to lot lines and the Town Trustees have gone to the trouble and expense of a re-survey, and are to pay three hundred dollars for a new map.

The territory comprises about one hundred and sixty acres and that is divided into five hundred and fifty lots.

A railroad runs angling through the section, so that the lot lines are not with the section lines, thus getting many point lots and angling lines. The sketch from which the map is to be made has so few distances given that the draughtsman was unable to make the map. More distances were sent him, not enough though to do him any good.

Finally another plat was sent, and now another survey will have to be made before the required distances can be given. On the first sketch I counted one hundred and fifty-seven places where distances should be, but are not.

That surveyor is either trying to keep private distances, or else he is trying to get his pay for just as little work as possible—perhaps a little of both.

Is there any wonder that the Hoosier surveyor gets so many stones thrown at him? We must not expect any thing else till we train ourselves to do better work.

On the other hand, a man, or a town board, who is so ignorant as to employ an unqualified surveyor to do the work, is just about ignorant enough, when an error is found, to blame the entire profession and say they are all alike.

Before we can reap any great benefit, we must educate ourselves and also the people to a higher standard of perfection than we have at present.

The City Surveyor should use good instruments and keep them in order, and so far as possible, where angles are required in cities, do not use the needle—get the angle from the vernier, as we do not know how streets and alleys will be underlaid with a net-work of gas-pipe or water-pipe, thus making the needle an unsafe angle reader.

Still so long as there are no established monuments in some cities, the lines are liable to vary, and then the angles are liable to vary more, so that the first thing I would like to see would be the monuments from which all surveyors could work. I believe the old-fashioned chain should be laid aside, as it is unfit for city use.

The graduation needs to be finer, and besides that, you can not keep the chain the right length.

I generally use Chesterman's steel tape, graduated to tenths, but there are other tapes I suppose just as good as this one.

I suppose there is a slight variation in length from extreme cold to extreme heat; but I believe there is a less variation in a narrow, thin tape without joints than in any other measure I have seen. The chainmen should not be sons of Councilmen or Town Trustees unless they have other qualifications than simply being the sons of the Councilmen or Town Trustees.

The cheapest is not often the best, and in fact I believe that that is seldom the case.

NATURAL GAS PLANTS.

BY J. R. BROWN.

The question of the permanency of the natural gas supply is a question in which all Indianians naturally take a very deep interest, as upon that question depend the "Sweet Home" comforts and the permanency of the numerous manufacturing establishments that have located within our borders in the last few years. Considerable apprehension of the failure of natural gas has arisen from the diminishing pressure of many wells in certain localities, and from the reports of the exhausted condition in some fields of Pennsylvania and Ohio. The exhaustion of a few

wells is no more a sign of the entire failing of the supply of gas, than the failure of the supply of oil in some localities of the oil region of Pennsylvania is that the oil supply is generally exhausted. For instance Pithole City in Venango County, Pennsylvania, which had a population of about 1,500 in 1866, had in 1880 dwindled down to less than 100, owing to the fact that the flow of oil diminished gradually until it became exhausted beyond paying quantities. An excitement then sprang up over the development of a few exceptionally strong wells in a locality about seven miles distant, and they immediately commenced moving Pithole City to the new field and christened it Pleasantville, which to-day, after a lapse of some twenty years, is a flourishing oil town, while Pithole City is a "deserted village."

There is no doubt but that the gas supply may become exhausted in certain localities of Indiana to such an extent that it would not pay to operate a gas plant, while at the same time strong wells might be developed in localities not many miles away that would supply the demand for a plant for many years to come without apparent diminution in pressure.

The Indianapolis *Sentinel* last week published a number of interviews that their correspondents had in the principal gas towns of Indiana. Some of the parties interviewed gave a good, sober expression of the situation and condition of things in their localities, while some gave it braggadocioally, and some under the intoxicating excitement of selfish rivalry and strife in trying to "boom" and outstrip all other towns in growth and population.

It is a difficult matter to arrive at the exact truth of the condition of things when you are interviewing a person on the importance and advantages of the town of his home; as selfish motives will sway a man's better judgment, weigh against neighboring towns, and in favor of the town of his home and choice.

The following are pretty full quotations taken from said interviews, and which are given here for the information they contain:

MUNCIE, January 11.

"All houses used as residences and every factory in Muncie are using natural gas for fuel. Further than this, it is used as an illuminant in 95 per cent. of the houses. There has not been the slightest decrease in pressure for three years. On the contrary, several wells have doubled their pressure, and the last well drilled, which was anchored January 2, is one of the best, if not the very best, in Indiana. Its capacity is estimated at 15,000,000 cubic feet of gas every twenty-four hours. It was drilled to supply the Port Glass Company with heat and light, and was not begun until the works were well up.

Gas is found every time a hole is sunk about eight hundred and fifty feet, no matter where the site. It costs about \$1,800 to own a gas-well on your lot. The whole of Delaware County, north, south, east and west, is a perfect gas-field, and gas can be obtained everywhere in it. The bottom of the wells is from twenty-five to a hundred feet above the sea level and as a consequence the gas obtained is perfectly dry, and there is not the slightest danger that salt water will ever block up the wells. A well which furnishes fuel for the nail works has yielded several barrels of petroleum, but with this exception (which is not a disadvantage) the wells yield nothing but pure, dry natural gas in unfailing amounts.

The leading natural gas men, while silent as to any special or personal information they may possess, unite in declaring that Muncie has more gas than can be used up for any purpose, domestic or manufacturing, in at least two generations.

HARTFORD CITY, January 12.

“To your question, “Is the pressure declining?” I will answer, No; it is stronger to-day in all wells in this county than when first drilled. There has never been a dry hole struck in the county. The Blackford County gas field is conceded by all to be the best uniform gas territory in the State. All factories use gas for fuel and light. Several large plants draw their supply from one well, and three years of heavy consumption has not weakened it in the least. One well, drilled in last week by the Hartford City Window Glass Company, is very large—equal to the Fairmount “Jumbo.” The roar of escaping gas, with the vibrations of the ground for a mile or more around, lasted four or five days—the time employed in getting it packed and under control—and caused great fear to the neighborhood. This well is on the Rasoner farm, about five miles southwest. The five wells drilled by this company are away above the average wells of the State.

The first gas well drilled in this State is located at Enlon, Indiana, seven miles south of here, and has been drawn upon very heavily. All the factories there use the gas; also the town and country are piped from it, and to-day parties from there say it is as strong as it ever was.

A theory advanced by many is that the crust of the earth is gradually cooling and shrinking, and we are enjoying the escaping gas which finds its way into the porous Trenton rock. So much for theory; and if true, we may expect gas for all time to come.

No, sir; in Blackford County there is no fear of gas giving out. There are men in this county that are harping on a theory that gas is playing out. Those are leasers, leasing lands for monopolies. They are

telling the farmers that gas is short-lived, and the time is short in which to realize on their gas land, and the farmers lease it to them, and they make all they can out of it. They are leasing considerable land, paying one dollar per acre for it, after they drill therefrom from one hundred to two hundred dollars per year. I think this is the source from whence the scare comes. They are increasing their farces of leases in this county. I have no idea but around the edges of the belt they are drawing on their wells faster than the gas is generated. We think the supply of gas in this county will last for all time to come.

MIDDLETOWN, January 12.

“While I do not apprehend that there is any danger of an early failure of gas in the great Indiana gas belt, it appears reasonable to me to believe that the supply must, at some time, become exhausted. If, as some claim, the gas was generated in past ages and is now being drawn from nature's great store-house, the supply will surely fail at some time. If, upon the other hand, it is now being generated, the causes which combine to produce the gas must, of necessity of themselves, sometimes fail. In either event there must be an end to the now wonderfully voluminous out-put of this agent which has done so much within the past three years to plant and develop material industries in the great State of Indiana. I do not wish to join in any cry of alarm, for I consider there is no present occasion for it.

Your reports indicate what I observe here, that there is no apparent diminution in either the daily out-put, or rock pressure, of gas from wells in this belt. Here, we are using gas from wells, one of which is now in its fourth year, and it is as strong, in every respect, as upon the day it was drilled in. Three other wells have since been drilled here, and each successive one was stronger than the preceding one, notwithstanding they are all grouped within an area of forty rods square. I do not doubt that the supply of gas is sufficient for several generations, but the useless and prodigal extravagance, amounting to absolute waste, noted all over the gas belt, is to be deplored. However long continued the supply may be, it is evident that it could be extended over a greater period of time if but ordinary prudence and economy in its use were practiced. While it is furnished consumers practically without price, its value can not be measured, hence it should be carefully husbanded, and companies having control of the supply should adopt and execute the most rigid rules and regulations looking to a prevention of this useless and extravagant waste. If it be within the power and scope of legislation to compel economy in the use of this fuel, the present session of the General Assembly should not hesitate to take hold of the matter

and enact a law to that end. It is not enough that we have the present resources to make Indiana the greatest manufacturing State in the Union. We want to preserve and protect, for the future, this subtle agent that is daily putting into motion the busy wheels of industry.

ANDERSON, January 11.

“There is perhaps a stronger belief among the people of Anderson than elsewhere in the gas belt that it will be many years, if ever, before natural gas will become exhausted. This feeling is due to the fact that the gas wells of this locality are exceptionally strong, and even now, after a lapse of almost four years since the first gas well was “drilled in,” there appears to be no perceptible diminution of the supply.

It is true that some fear exists that the gas supply may soon become exhausted. This fear is not caused by any indications of failure in the local field, but rather to the reports of gas failure that come from other localities where gas is found.

The consumption of gas at this point is perhaps greater than at any other town in the Indiana gas belt. It is estimated that no fewer than three thousand residences and business rooms are heated and lighted by gas, and, in addition to this, eighteen large iron and glass-working factories, to say nothing of other smaller factories, depend solely on natural gas for fuel.

To supply fuel and light for the purposes named, thirty wells have been drilled, and are now attached to gas mains, within a radius of one and a half miles from the court-house square. It must not be inferred from this that thirty wells are necessary to the supply, for such is not the fact. The Citizens' and Doxey Gas Companies, which supply a large majority of the private consumers, have, the former but three, and the latter two wells—one at each end of the system. Other gas companies, that supply the outlying additions, have from one to two wells each. Each factory controls its own gas supply, and has a well adjacent, from which it alone obtains gas.

NOBLESVILLE, January 10.

The natural gas situation in Hamilton County is assuming a very discouraging aspect. From the most experienced men now employed by gas companies in this city, comes the cry, “the gas supply is declining.” This fuel is now employed in generating steam by all the factories and mills that are accessible, and no thought is entertained of shutting off this supply, for the reason that Hamilton County is situated directly over a rich gas field, and so long as gas is utilized for domestic purposes it will also be used for manufacturing. It is a fact undisputed by every

man interviewed that the supply is slowly diminishing, and to substantiate this statement, Frank Stebbins, a man of fourteen years' experience in the oil and gas fields of Ohio and Pennsylvania as a driller, informs us that wells drilled by the Noblesville Gas and Improvement Company two and a half years ago, whose pressure at the time of their development was 335 pounds to the square inch, have diminished since then to 270 pounds, a decrease of 65 pounds in thirty months. But, notwithstanding this slow decrease in pressure, the supply promises to be adequate for towns which are fortunate enough to be located in the belt, for years to come, and at a date when large pipe lines, through which the volatile substance is now fugaciously wending its way to larger towns, will be spoken of as enterprises of the past. Mr. Stebbins also says that the wells of the Indiana gas field will stop yielding sooner than those of the Ohio field, and assigns these reasons:

Underlying the porous trenton rock in the eastern fields is a large body of sand, averaging in thickness perhaps twenty feet, which affords an excellent reservoir for gas and oil; while nothing of the kind lies beneath the rock in Indiana in which the supply can be retained, hence the slow decrease. Furthermore, he says that within the next year, or eighteen months at the longest, although the denizens of the locality in which gas is found may have an abundance, there will be scarcely enough passing through the large pipe lines that are now attached to this field to produce even a small dividend to the stockholders of the concerns.

Many other prominent gas men of this city were interviewed by your correspondent, and with one exception they declared that ultimately the gas would cease to flow. One good authority, however, expressed the opinion that the supply would last indefinitely, for the reason that no wells have yet totally failed unless the flow was shut off by water, and then new wells have been successfully developed in the immediate vicinity.

MARION, January 10.

"I have taken special pains to make inquiry regarding natural gas in this particular vicinity, as per instructions. The pressure of our wells is not diminishing perceptibly. We find that the quantity flowing from three of them is less in any given time than when it was first struck. The pressure in even these wells attains the same height if the gas is confined long enough. The theory is, therefore, that the means of access into the wells become somewhat obstructed, and if these obstructions were removed, there would be no perceptible diminution in the supply.

Gas is supplied for all purposes requiring fuel, and there is no probability of its use being curtailed in any way.

Mr. James F. Gabby, Superintendent of the Mississinnewa Mining Company, said: "If you ask, 'Is the supply of gas in this vicinity lessening?' I answer, no. We have practically as nearly an inexhaustible supply as ever. There are some reasons why the man who only knows what is in the reach of all to know, may think it is lessening; for instance, our stove-works well seems to be almost exhausted, and yet the rock pressure is as great as ever. That well has oil in it, and also some salt water; these it had from the start. From these substances there is the formation of crystalized salt and paraffine in the pores of the rock. This eventually so nearly closes them up that the gas can not enter freely into the well. We know the pressure is the same, because when we close the well up, it soon attains a pressure as great as it had at the start. It will be observed that those wells upon which the draught is heaviest seem to choke up soonest; this is caused by entirely relieving the head or back pressure in the well, the oil and water finding their way into the well more readily. 'Shooting' will not always make a good well of it, as the accumulation of crystal and paraffine fills out too far through the fissures. A well sunk within a few feet of the one thus apparently exhausted will be as good as the former one was originally. The well we drilled in the other day for the stove-works is equal to any one we have struck in that part of the field.

"If you ask me when the field will be practically exhausted, I will answer, When there is no more room on the surface to put down wells. If drawn upon at its full flow, a well will choke in about three years; if a good back pressure of—say two hundred pounds—is allowed to remain in the well, it will take many years to exhaust, or 'choke' it rather, if ever."

LAFAYETTE, January 10.

"We draw our gas from 12,000 acres of land near Kempton. We have sixteen large wells now flowing and are sinking others. The gas is piped thirty-seven miles. We have twenty-one miles of eight-inch and sixteen miles of ten-inch pipe. The last and best well was opened on Christmas day. On the line of pipe we have 4,500 consumers and 8,000 fires. Manufacturers consume more than half the gas and pay less than other consumers and we do not care to cater to them. If Chicago will keep out of our field, if the consumers will use meters and only what fuel they actually require, the gas will last a lifetime. The pressure fluctuates in winter and summer, but not enough to cause any trouble or to produce a scarcity. We have enough gas to supply double the demand we have now. The pressure at noon to-day was 330 pounds, as

much as at any time since the introduction of gas on July 4, 1889. We have a splendid plant, plenty of gas and are not fearful of the future.

FRANKFORT, January 11.

“The natural gas pressure has not declined any yet at this place. Aside from domestic purposes, gas is used here for several factories, and the company has no intention at present of discontinuing its use in any factory. The company is anxious to extend its use to other factories. Leading gas men think the supply will eventually fail, but they are of the opinion that the supply will last for many years, unless too heavily drawn upon by remoter points.

The field from which Frankfort receives her supply is in the eastern part of the county, and its area is not very large. The city of Lafayette now has a pipe line and draws her supply from the same field, and it is learned that Delphi is now endeavoring to secure territory in the same field.

Lafayette, with her large population and numerous factories, makes a heavy drain upon the gas field, and the Frankfort demand will be largely increased by the location of the Clover Leaf shops here. If, in addition to these draughts upon this field, Delphi pipes gas from it, many of our best informed gas men fear the supply will be exhausted within a few years.

WINCHESTER, January 11.

“We have drilled in all twenty-two wells, and have abandoned eight as being worthless. We have five wells that are small producers. We have nine wells that are good, and will average not less than a million feet per day. Our gas is used for domestic purposes only. The rock pressure, when the wells were first drilled, was 365 pounds; at present, after two years, it is 275 pounds. The wells have some water and show some oil. We have 1,200 stoves running and 600 lights. We are supplying no street torches. We supplied the first stoves with gas in the State, and Muncie was next.

SHELBYVILLE, January 10.

“That gas wells lose their pressure from consumption, all gas people now admit, though few have admitted that artificial reservoirs must finally be adopted if we expect to continue the use of natural gas for fuel and illuminary purposes. Under the present system of utilizing gas 75 per cent. of

the gas is lost by leakage from the mains and by being forced into the porous strata of sand, shale and clay from the fissures caused by shooting wells. Take, for instance, the gas line from Greenfield to Shelbyville, a distance of twenty miles. Say the pressure at the wells is 210 pounds to the square inch. The loss of pressure in forcing it through an eight-inch main is seven pounds to the mile, which makes a loss of 140 pounds of pressure, leaving but 70 pounds pressure when it gets to the city limits. Again, a governor is attached and more resistance made, which reduces the pressure to the consumer. Finally the pressure is reduced to less than one pound to the square inch—usually to about seven ounces. Practically, then, the entire 210 pounds pressure is turned upon the weak points of the well, which is full of flaws and leaks. In the first place, the crest or roof of the gas pocket has been shattered and riven by explosions and the well tamped at some point, usually about two hundred feet above the bottom of the wells, and when the resistance is made necessary to give the gas pressure, it is forced into the fissures and through the porous strata of the earth into pockets of drift, and many times to the very surface of the earth. The gas mains are also subject to great expansion and contraction, and where the resistance is applied the mains leak from one end to the other. Under the present system too much is required of nature's forces. No resistance should be made to the gas, and its exit from the bowels of the earth should be made easy. The pressure should be made on top the earth by means of reservoirs. It would be folly to assume that artificial gas could be supplied for use with sufficient pressure derived from the point of generation, and why should we expect that spontaneous generation of gas should be strong enough to furnish pressure? C. E. Erdhouse, an old gas man, is of the opinion that many wells are destroyed by the use of explosives, causing the great volume of gas to escape into the sub-strata of the earth. This theory is substantiated by the fact that in all gas fields which have been tapped the gas escapes even into the soil, and frequently causes the water in wells to taste of gas. Especially has it been demonstrated in Shelby County. In Van Buren Township, near Fountaintown, where two wells have been anchored, the well of a farmer became infected with gas, and, upon investigation, he found a strong flow of it. He anchored the water-well and piped the gas into his house, and has been using it as fuel every since. Last August, at a point three miles from the wells at Waldron and St. Paul, on Flat Rock Creek, the surface gas collected in a reservoir fifty feet below the surface, and a match being lighted at a point where it was escaping, an explosion occurred by which ten acres of earth were torn to pieces with

every appearance of a volcano. Four miles farther west, on William Patterson's farm, a tenant was digging a well last September, and when about fourteen feet deep, having pierced the hard-pan, the sand and gravel began going out the top of the well, and the smell of gas was detected. He got out as quickly as possible and the well was abandoned."

On the 13th day of January, 1891, the Central Ohio Natural Gas and Fuel Company notified their 1,300 domestic consumers at Columbus, Ohio, that they would have to prepare themselves for some other kind of fuel, as the gas pressure dwindled down so low on that day that many fires in the city went out; and the company feared accidents might happen, if they should endeavor to continue under these circumstances. The continued cold weather made such a draft on the wells, which are located at Thurston, twenty-seven miles southeast of the city of Columbus, that the pressure ran down to twenty pounds at the field, with four and one-half pounds at the city limits and only one ounce and a half in the system throughout the city. The company thought that after the cold weather was over, they might be able to resume and furnish gas to those with whom they had contracts.

The following description of the plant at Columbus is an extract from the official report made by E. B. Philipp, an expert Gas Engineer of Findlay, Ohio, to the committee to investigate the condition of the Central Ohio Natural Gas and Fuel Company :

"The supply of gas has been obtained at Thurston, about twenty-seven miles southeast of Columbus, and conveyed through a field line of ten and twelve-inch pipe. At Thurston, the field end of the line, a reducing station controls the pressure on the main line; and branch lines from all the wells run to and converge at this reducing station. The object of this reducing station is to reduce the pressure from what is known as the well pressure to what is termed as the line pressure. This line pressure was needed and was used to force the gas through the twenty-seven miles of field line, for delivery at Columbus. For this purpose it was necessary to carry at the reducing station at Thurston a pressure varying from 100 to 60 pounds. This pressure, after forcing the gas through the twenty-seven miles of field line, was reduced at the terminal end of the line to a pressure varying from seventy-five to five pounds. At the end of the twenty-seven miles of field line, just outside the corporation, another reducing station controlled and reduced this pressure to ten pounds and under; this pressure being carried upon the city belt high-pressure line surrounding the city. This belt high-pressure line supplied the low-pressure city lines at different points, the pressure being controlled and the low-pressure lines fed by a number of low-pressure regulators. At

the pressure thus controlled the gas was delivered from the low-pressure lines in the streets and alleys to the consumer. The plant consisted of large-sized pipe, and was well equipped and well adapted to give good service.

The following tabulated pressures were taken from the office pressure sheets of said gas company, and were sworn to and certified as correct by the superintendent of the company:

PRESSURES.	Max- imum.	Mini- mum.
<i>Well Pressures.</i>		
November 18, to December 9, 1890	210 lbs.	43 lbs.
December 9, 1890, to January 15, 1891.	180 "	23 "
<i>Main Field Line Pressure at Thurston.</i>		
November 18, to December 9, 1890	100 "	43 "
December 9, 1890, to January 15, 1891.	80 "	23 "
<i>High Pressure, City Belt Line.</i>		
November 18, to December 9, 1890	12½ "	3½ "
December 9, 1890, to January 15, 1891.	10 "	
<i>Low Pressure, City Lines.</i>		
November 18, to December 9, 1890	4 $\frac{8}{10}$ oz.	4 $\frac{8}{10}$ oz.
December 9, 1890, to January 15, 1891.	4 $\frac{8}{10}$ oz.	1 $\frac{6}{10}$ oz.

It will be conceded by all natural gas engineers that the well pressure of from 180 to 23 pounds is unsafe, in so far as the life of the well is concerned, as at this pressure the column of salt water, continually aggressive, would enter the gas rock, finally drown out and ruin the well.

Careful and accurate tests were made by said Engineer and the Investigating Committee, of all the wells in the Thurston field after they had been shut down and confined for some time.

The tests were made as to rock pressure, volume, etc., a reasonable length of time being allowed to reduce the head or confined pressure of each well, so as to obtain as practically as possible the normal flow.

The result of these tests is as follows :

NAME OF WELL.	Rock Press. When Drilled, Pounds.	Rock Press. When Tested, Pounds.	Flow Per Day When Drilled, Feet.	Flow Per Day When Tested, Feet.
Feeman	750	570	2,023,700	2,023,700
Ruffner	750	380	7,123,000	2,023,700
Lamb, No. 1.	750	275	6,706,500	1,572,000
Fisher, No. 1.	750	285	7,085,250	991,370
Fisher, No. 2.	750	285	6,706,500	991,370
Joe Hite, No. 2.	750	275	5,400,250	991,370
Weaver	750	280	6,241,500	701,400
Abe Hite	750	495	1,266,000	584,880
Watson, No. 2	750	250	3,657,300	276,750
Lamb, No. 2.	750	270	2,550,200	232,880
Goss.	750	190	5,168,000	197,260
Soliday	750	375	700,000	200,000
Taylor.	750	690	700,000	
Bush	750	360	500,000	
McNamee	750		250,000	
Don S.	750		2,156,000	
Musser	750		1,300,000	
Geiger.	750		1,250,000	
Watson, No 1	750		600,000	
Watson, No. 3	750		800,000	
Total			62,178,200	10,786,680

From the foregoing table it will be seen that of the twenty producing wells originally drilled, eight were found at the time of the test, practically dry and non-producing; the remaining twelve of the twenty wells being found producing gas in the volume as given. The total production, or normal flow, of the twelve producing wells is found to be 10,786,680 cubic feet per day. It would be impracticable and conducive to the death of the wells to work them up to their normal flow, and the best practical gas engineering would only allow about one-half of their production to be used, so as to keep enough head or back pressure in the rock to prevent the ingress of salt water, and the resultant flooding of the rock and the death of the wells.

This would actually reduce the available amount of gas at the wells to 5,393,340 cubic feet per day. The best practice in transporting gas through a pipe line thirty miles long, taking into consideration and providing for the protection of the wells, which is absolutely necessary, would result in a possible delivery at the terminal end of this line, of not more than 20 per cent. of the normal flow of the wells. This would cut down the actual available delivery to about 1,078,668 cubic feet.

The record of all the wells shows that in round numbers about 30 per cent. of the wells drilled were dry, and that about 40 per cent. of the producing wells drilled and producing when drilled became exhausted and dry, making a total actual loss of wells drilled of about 60 per cent. The net loss of volume or flow is about 80 per cent. The net loss of rock pressure is about 52 per cent.

The data and figures obtained in this investigation have been carefully made, for on the data thus ascertained and summarized the expert based his opinion, given to the committee, that the Thurston field in that condition was entirely inadequate to furnish Columbus with a sufficient supply of natural gas, even to the extent of the number of stoves that were attached to the lines, and that the Central Ohio Natural Gas and Fuel Company was entirely justified in cutting off the supply."

Chemically considered, the composition of natural gas is principally CH_4 , which, divested of its technicality, means essentially carbon or marsh and hydrogen gases, on an average proportion of 1 to 4 parts of atomic weight, mixed with small percentages of half a dozen other different gases, the composition varying with almost every sample taken from the same well. Compared with coal, 1,000 cubic feet of natural gas is equal to about fifty pounds of bituminous coal.

Natural gas is certainly a great blessing to those who are fortunate enough to live in or near the gas belt; and those having once enjoyed the comforts that exist in its convenience and cleanliness would come to the full appreciation only after having the supply shut off all at once, as the people of Columbus, O., experienced to their great discomfort.

As the practical utility of natural gas plants depends altogether on the permanency of the supply, the subject can not be fully discussed until a great deal more practical experience shall have been added to that of the past.

ADVERTISEMENTS.

The attention of cities, towns, corporations and county commissioners having bridges to build or other iron or steel structural works of any kind, is particularly invited to the advertisement of the old reliable King Iron Bridge and Manufacturing Company on the second page of the cover of this report.

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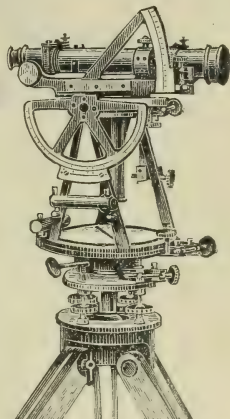
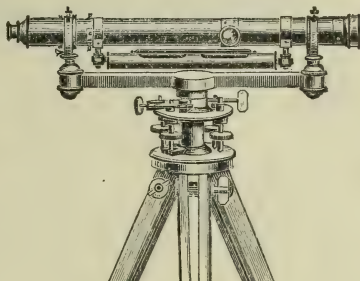
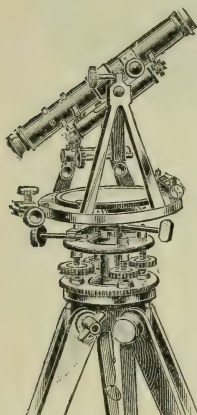
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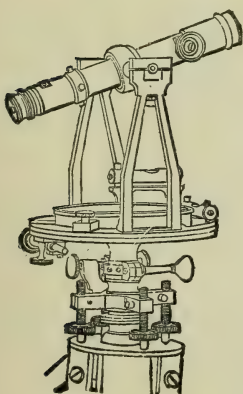
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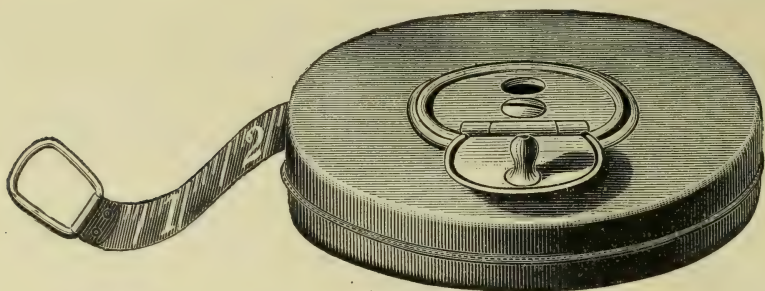
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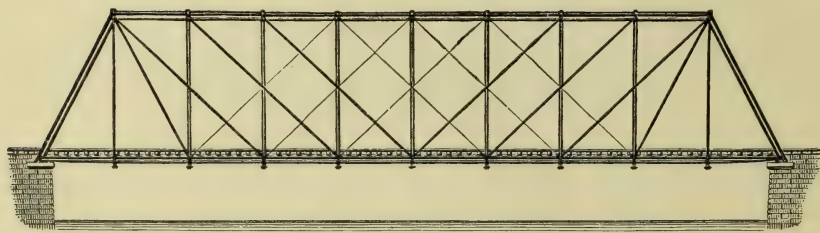
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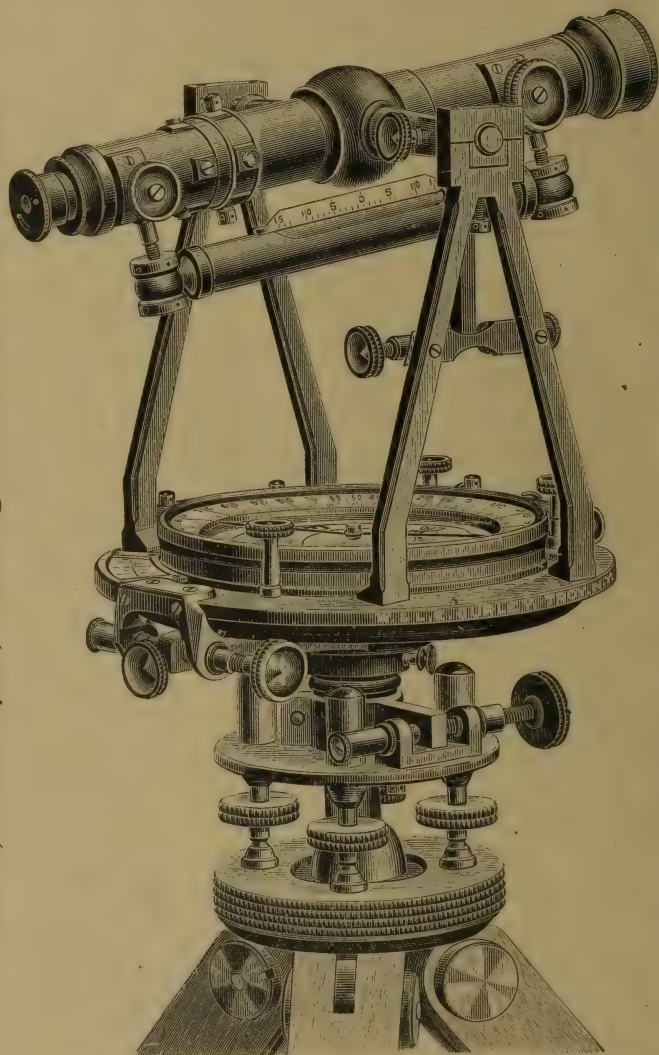
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TWELFTH ANNUAL REPORT

OF THE

❖ INDIANA ❖

Engineering Society,

CONTAINING THE PROCEEDINGS OF THE SOCIETY

AT ITS

TWELFTH ANNUAL MEETING

HELD AT

LaFayette, Ind., Jan. 12, 13 and 14, 1892.



PRICE, 50 CENTS.



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OFFICERS AND STANDING COMMITTEES.

PROF. A. E. PHILLIPS, President, - - - LaFayette, Ind.
J. F. O'BRIEN, Vice-President, - - - Cloverdale, Ind.
W. P. CARMICHAEL, Recording Secretary, - State Line, Ind.
E. B. VAWTER, Corresponding Secretary, - LaFayette, Ind.
H. B. FATOUT, Treasurer, - - - - - Indianapolis, Ind.

EXECUTIVE COMMITTEE.

Prof. A. E. Phillips.	E. B. Vawter.	Wm. M. Whitten.
R. I. Morrison.		H. B. Fatout.

COMMITTEE ON LEGISLATION.

Wm. M. Whitten.	J. R. Brown.	Prof. J. L. Campbell.
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COMMITTEE ON DRAINAGE.

Wm. M. Whitten.	J. E. Alter	Jno. P. Doyle.
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COMMITTEE ON ENGINEERING AND SURVEYING.

Prof M. J. McCue.	N. A. Beck.	C G. H. Goss.
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L. S. Alter.	R. I. Morrison.	J. F. O'Brien.
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COMMITTEE TO COMPILE AND PUBLISH REPORT.

W. P. Carmichael.	J. R. Brown.	Everett B. Vawter
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MEMBERS' DIRECTORY.

NAME.	BUSINESS.	RESIDENCE.
Alter, Lewis S.	Assistant City Engineer and Deputy County Surveyor	South Bend, St. Joseph Co., Ind.
Alter, John E.	Drainage Engineer	Rensselaer, Jasper Co., Ind.
Brown, Chas. S.	Ph. E., Prof. of Mach. Design and Sup't of Shops at Rose Polytechnic Ins.	Terre Haute, Vigo Co., Ind.
Brown, Jas. R.	Surveyor and Civil Engineer	Frankfort, Clinton Co., Ind.
Burner, Hiram		Westville, Ind.
Bortner, H. S.	County Surveyor	Albion, Noble Co., Ind.
Beck, N. A.	County Surveyor and Civil Engineer	Logansport, Cass Co., Ind.
Campbell, John T.	B. S., M. S. C. E., and M. D.	Rockville, Parke Co., Ind.
Carter, Calvin	County Surveyor and Civil Engineer	Brookville, Franklin Co., Ind.
Carmichael, W. P.	City Civil Engineer	State Line, Warren Co., Ind.
Cheney, Geo. M.	Mechanical Engineer	Logansport, Cass Co., Ind.
Carr, Thos. A.	Surveyor and Civil Engineer	Oolitic, Lawrence Co., Ind.
Clogston, W. W.	County Surveyor	Lyons, Green Co., Ind.
Coyner, Jas. S.	Civil Engineer	Noblesville, Hamilton Co., Ind.
Coyner, John V.	County Surveyor	74 E. Market St., Indianapolis, Ind.
Downey, Morton H.	County Surveyor	Alexandria, Madison Co., Ind.
Doyle, John P.	County Surveyor	Fowler, Benton Co., Ind.
Dalton, Lycurgus	Surveyor and Civil Engineer	Mitchell, Lawrence Co., Ind.
Fatout, H. B.	Civil Engineer and Contractor	Indianapolis, Marion Co., Ind.
Fries, W. S.	City Civil Engineer and County Surveyor	Greenfield, Hancock Co., Ind.
Finley, Thos.	County Surveyor	Shelbyville, Shelby Co., Ind.
Fisher, John	Surveyor and Civil Engineer	Crown Point, Lake Co., Ind.
Fawcett, J. W.	City Civil Engineer and County Surveyor	Delphi, Carroll Co., Ind.
Goss, Curtis G. H.	Surveyor	Martinsville, Morgan Co., Ind.
Gilbert, N. W.	City Civil Engineer and County Surveyor	Angola, Steuben Co., Ind.
Harris, G. W.	City Civil Engineer and County Surveyor	Maxville, Vigo Co., Ind.
Howard, R. A.	City Civil Engineer	Richmond, Wayne Co., Ind.
Horan, Michael	Special Surveyor for County Commissioners	Peru, Miami Co., Ind.
Hill, W. B.	Professor in Danville Normal College	Frankfort, Clinton Co., Ind.
Hargrave, Chas. A.	Civil Engineer—County Auditor	Danville, Hendricks Co., Ind.
Johnson, T. J.	County Surveyor	Mt. Vernon, Posey Co., Ind.
Jackson, C. S.	Civil Engineer and Deputy County Surveyor	Peru, Miami Co., Ind.
Knight, Frank	Civil Engineer	Crown Point, Lake Co., Ind.
Mayfield, Robt. P.	Civil Engineer	Vincennes, Knox Co., Ind.
Morrison, Robt. I.	County Surveyor	Knightsstown, Henry Co., Ind.
Miles, Chas. W.	County Surveyor	San Jacinto, Jennings Co., Ind.
McConnell, Ira	County Surveyor	Crawfordsville, Montgomery Co., Ind.
McCartter, Geo. W.	Professor of Civil Engineering in Notre Dame University.	Warsaw, Kosciusko Co., Ind.
McCue, M. J.		South Bend, St. Joseph Co., Ind.

Meighan, J. F.	Ass't City Civil Engineer and late Dept. U. S. Surveyor of New Mexico .	South Bend, St. Joseph Co., Ind.
Marshall, Wallace	Chief Engineer LaFayette Bridge Co.	LaFayette, Tippecanoe Co., Ind.
North, Achilles	County Surveyor and Civil Engineer	Plymouth, Marshall Co., Ind.
Norris, Jacob	Professor of Mathematics and Civil Engineering in Wabash College (Now Rev. Jacob Norris)	Crawfordsville, Montgomery Co., Ind.
O'Brien, Wm. G.	Civil Engineer, Ass't Engineer N. T. W. R. R.	Laramie, Wyoming
O'Brien, J. F.	County Surveyor	Richlands, Tazewell Co., Va.
Osmer, W. A.	Chief Engineer Indianapolis, Logansport & Chicago R. R. .	Cloverdale, Putnam Co., Ind.
Pulse, J. C.	On U. S. Surveys Indian Territory	Logansport, Cass Co., Ind.
Phillips, A. E.	Professor of Civil Engineering in Purdue University	Greensburg, Decatur Co., Ind.
Quigley, ...	Deputy County Surveyor	LaFayette, Tippecanoe Co., Ind.
Rogers, C. F.	City Civil Engineer, Dunkirk	Montgomery, Daviess Co., Ind.
Romack, Jas. L.	City Civil Engineer and County Surveyor	Portland, Jay Co., Ind.
Rader, M. A.	County Surveyor	Tipton, Tipton Co., Ind.
Smith, Ansel R.	County Surveyor and Civil Engineer in charge of Government Work for Dept. U. S. Surveyor at National Soldiers' Home	Monticello, White Co., Ind.
Smith, A. W.	City Civil Engineer	Marion, Grant Co., Ind.
Shea, Jas. W.	Civil Engineer	Kokomo, Howard Co., Ind.
Saunders, Jas. D.	Civil Engineer and General Contractor	Wabash, Wabash Co., Ind.
Swain, A. A.	Government Mineral Surveyor	Evansville, Vanderburg Co., Ind.
Smith, W. C.	Surveyor and Civil Engineer	Seattle, Washington
Smith, Craven	Civil Engineer and Contractor	74 E. Market St., Indianapolis
Thrawls, Jas. C.	County Surveyor	Delphi, Carroll Co., Ind.
Tecters, J. C.	Instructor in Civil Engineering in Purdue University . .	Rensselaer, Jasper Co., Ind.
Wagner, Everett B.	Civil Engineer	LaFayette, Tippecanoe Co., Ind.
Wagoner, Henry W.	City Civil Engineer	LaFayette, Tippecanoe Co., Ind.
Whitten, Wm. M.	City Civil Engineer and State Engineer of Kankakee River Improvement	Huntington, Huntington Co., Ind.
Wright, Jas. O.	Civil Engineer and Contractor of Steam Dredging	South Bend, St. Joseph Co., Ind.
Waugh, Jas. M.	Civil Engineer	LaFayette, Tippecanoe Co., Ind.
Warren, Albert K.	Civil Engineer	Crawfordsville, Montgomery Co., Ind.
Winslow, W. W.	Agent Canton Iron Bridge Co.	Lebanon, Boone Co., Ind.
		Indianapolis, Ind.

HONORARY MEMBERS.

NAME.	BUSINESS.	RESIDENCE.
Billingsley, J. J. W.	Publisher Drainage Journal	Indianapolis, Ind.
Beckmann, L.	Manufacturer Surveying and Engineering Instruments . .	Toledo, O.
Dover, H. L.	Agent J. W. Queen & Co.	Philadelphia, Pa.
Gruley, L. E.	Manufacturer Surveying and Engineering Instruments . .	Troy, N. Y.
Hodgman, Frank	Author of Manual on Land Surveying	Climax, Mich.
Randolph, T. F.	Manufacturer Surveying and Engineering Instruments . .	Cincinnati, O.
Sturgeon, Charles	Agent Columbus Sewer Pipe Co.	Columbus, O.
Watson, T. N.	Manufacturers of Engineering, Mining and Surveying Instruments .	Philadelphia, Pa.
Young & Sons		Philadelphia, Pa.

THE INDIANA ENGINEERING SOCIETY as a body, is not to be held accountable for any *heretical* or opinionated statements advanced in any of the papers published in this report; but since the object of the Society is for professional advancement, and since progress and development lie outside of the *old ruts*, in the open field—the field of investigation and experiment—the Society says to each one of its members, “Stand up and speak your piece, for the successful men in opening up new highways are the outspoken ones, who look with contempt upon the *beaten paths*.”

ABSTRACT OF PROCEEDINGS.

TUESDAY, January 12, 1892.

The Indiana Engineering Society convened in regular annual session at 2.45 P. M., at Purdue University Chapel, President Morrison in the chair.

Recording Secretary Brown called the roll of members, showing the presence of a quorum.

The Society then entered upon the following

PROGRAM.

TUESDAY, JAN. 12, 1892.—2 P. M.

Roll Call.

Address of Welcome, by President Jas. H. Smart, of Purdue University.

Response, by R. I. Morrison, President Indiana Engineering Society.

Reports of Officers, Recording Secretary, Corresponding Secretary and Treasurer.

Address of Retiring President.

Action on Resignation of President-elect, Prof. Jacob Norris.

Installation of Officers elect.

Address of President.

NIGHT SESSION.

*Levees—Construction of—Paper by John O. Bannon, South Bend.
Repairing Ditches, Act of 1889, Paper by N. A. Beck, Surveyor Cass county.

*Tile Drainage, Paper by M. A. Rader, ex-Surveyor White county.

Unfinished Business.

Miscellaneous Business.

WEDNESDAY, JAN. 13.—MORNING SESSION.

. Reports of Standing Committees.

. Reports of Special Committees.

*Columbian Exposition, Paper by Lewis S. Alter, Rensselaer.

Water-Supply Engineering, Paper by Prof. A. E. Phillips, Purdue University.

Earth-work ; New Methods of Computation from Tables, by John F. Meighan, South Bend.

AFTERNOON SESSION.—2 TO 4 P. M.

Special Tests in Civil Engineering, given in the New Engineering Laboratory, by Officers of the Purdue University, for the benefit of the Indiana Engineering Society.

4 TO 7 P. M.

Kankakee Drainage, Paper by W. M. Whitten, City Engineer, South Bend.

Discussion, Opened by Prof. J. L. Campbell, of Wabash College, late Engineer in charge of Kankakee Drainage Surveys.

NIGHT SESSION.

Unfinished Business.

Election of New Members.

*Ditch Repairs, Paper by J. N. McCormack, Surveyor Starke county.

*Bridge Work, Paper by C. B. Peterson, of Purdue.

*Drainage, Paper by Geo. A. Eagleton, Surveyor LaGrange county.

*Drainage, Act 1891, Paper by John C. Thrawles, Surveyor Jasper county.

Joys and Sorrows of the Drainage Engineer, Paper by John E. Alter, Rensselaer.

THURSDAY, JAN. 14.—MORNING SESSION.

Program for Next Meeting.

Appointment of Standing Committees.

Some Qualifications of the Engineer, Paper by Everett B. Vawter, LaFayette.

A Short Talk on Bridges, Address by Prof. A. E. Phillips, of Purdue.

A Survey in Vigo County—Importance of Correct U. S. Field Notes, Paper by J. T. Campbell, Rockville.

Election of Officers.

Miscellaneous Business.

Adjournment, *sine die*.

Professor Stanley Coulter appeared for President Smart, who was prevented from attending by illness, and welcomed

*Papers not presented.

the Society to Purdue University, extending to the members the privileges of the buildings and grounds.

President Morrison, for the Society, responded to Prof. Coulter's welcome, and addressed the Society in a few fitting words, as follows, preparatory to his retirement from the chair.

**ADDRESS OF THE RETIRING PRESIDENT,
R. I. MORRISON.**

"In retiring from the chair, I wish to extend my thanks to every member who has assisted me, in any way, in furthering the interests of the Society. I thank you, one and all, for your uniform courteous treatment.

"There is no need of a speech from a retiring man—it is: What will the new President say? that you are interested in hearing; and a regular speech from him is always in order.

"The next thing on our program is: Action on Resignation of President-elect, Prof. Jacob Norris. In reference to this matter I have to state that, on the 16th of September, last he informed me, by letter, that he had accepted a charge in Laramie, Wyoming—had resigned his chair in Wabash College, and now placed in my hands his resignation of the Presidency of our Society, as he expected to leave at once for his new field of labor.

"Prof. Norris, since he first met with us, has been enthusiastic and untiring in his labors for the welfare of the Society. In getting out the last Report his services were invaluable. The papers he has contributed have added much of interest to our meetings, and have possessed a high order of merit. Though he has changed the prefix of his name from 'Prof.' to 'Rev.,' it is not improbable that he can find time, taken from his ministerial duties, to contribute a few papers to our Reports, enough, at least, to keep well brushed up the solid

mathematics which he was wont to hammer into the boys of Wabash College. As he is not far enough West to be out of reach of the mails, in behalf of the Society, I invite him to send us a mathematical problem, or anything else he may think we need to make our Reports entertaining to the engineering fraternity.

“What action shall be taken in reference to this resignation?”

A motion was made and carried, to proceed to the election of President, to fill the vacancy caused by Prof. Norris' resignation.

Prof. A. E. Phillips was placed in nomination and, on motion, was elected President of the Society by acclamation.

President Phillips upon taking the chair made a few remarks, after which the regular program was taken up.

A number of names of applicants for membership were presented and referred to the Executive Committee for investigation and approval.

On motion, the Society adjourned to meet at the Court House in LaFayette, at 7.30 P. M.

EVENING SESSION.

The Society convened at the appointed time and place.

Mr. Jno. O'Bannon not being present to present his paper on “Construction of Levees,” on motion, the report of the Committee on Drainage was called for and presented by Mr. L. S. Alter, Chairman of the Drainage Committee.

The discussion of this report was participated in by Messrs. Beck, Whitten, Doyle, O'Brien, Alter and Fatout.

Mr. Rader being absent, on account of sickness, his paper on “Tile Drainage” was passed.

Mr. O'Brien announced to the Society the death of Ex-President, R. H. Walls, of Greencastle; and Mr. Alter, that of J. C. Truitt, of Muncie. Mr. Alter moved the appointment of a committee to suggest appropriate action relative to the death of these members, the motion was agreed to and the President appointed Messrs. O'Brien, Goss and Alter on the committee.

Mr. Brown moved the appointment of a committee of three members, which, with the President, be instructed to consider the matter of revising the Constitution of the Society, and report at the next annual meeting.

Mr. O'Brien moved to amend the motion by requiring the committee to report at the final session of the present meeting.

The amendment was lost and the original motion carried.

The Chair announced that the appointment of the committee would be made at the next session.

After a recess of ten minutes, the Executive Committee reported, recommending the following names for membership:

Prof. M. J. McCue, of Notre Dame University, South Bend.

John F. Meighan, late Deputy U. S. Surveyor, of New Mexico, Assistant City Engineer of South Bend.

Jno. E. Alter, Drainage Engineer, Rensselaer.

Jno. P. Doyle, County Surveyor of Benton county, Fowler.

Lycurgus Dalton, County Surveyor of Lawrence county, Mitchell.

J. C. Teeters, Instructor in Civil engineering, Purdue University.

On motion of Mr. Alter, the report of the committee was concurred in and the gentlemen recommended were elected members of the Society.

The Society adjourned for the evening.

MORNING SESSION.

WEDNESDAY, Jan. 13, 1892.

The morning session opened promptly at 9.15 o'clock, President Phillips in the Chair.

The minutes of preceding meetings were read and approved.

The Chair announced the Committee on Revision of the Constitution to consist of Messrs. Fatout, Vawter and Carmichael.

Chairman Fatout presented the report of the Committee on Engineering and Surveying, which was adopted without discussion.

L. S. Alters, for the Committee on the Columbian Exposition, reported by reading a number of circulars received in his correspondence with the officers of the Exposition, which on motion, were referred to the Committee on Compiling and Printing of Report.

A. E. Phillips presented the subject of "Hydraulic and Sanitary Engineering," supplementing his paper by a set of specifications for a stand-pipe, which was followed by a discussion of Prof. Phillips' paper.

"A New Method of Calculating Earth-work from Tables" was the title of a paper by John F. Meighan, which was followed by an explanation and practical demonstration of the merits of the method.

On motion of Mr. Fatout, Mr. Meighan was requested to have his paper published in the annual report of the Society.

The Executive Committee, by its chairman, recommended the following names for membership:

N. A. Beck, County Surveyor of Cass county, Logansport, Ind.

Jas. S. Coyner, County Surveyor of Hamilton county, Noblesville, Ind.

Jno. W. Fawcett, Civil Engineer, Delphi, Ind.

Wallace Marshall, Chief Engineer LaFayette Bridge Works.

The recommendations having been accepted and the gentle-

men elected members of the Society, the Society adjourned to meet at the Engineering Laboratory, at 1:30 P. M., and witness the operation of new apparatus and to re-convene in the chapel at 4 o'clock.

AFTERNOON SESSION.

WEDNESDAY, Jan. 13, 1892.

From 2:00 o'clock to 3:30 the members of the Society spent a most profitable hour-and-a-half inspecting the new Engineering Laboratory, and witnessing tests of strength of materials, flow of water over weirs and through orificies, etc.

At 3:30 the Society convened at the University Chapel, and the report of the Committee on Highways and Bridges was presented by Chairman Whitten. Discussion of the report was carried on by Messrs. Carmichael, Wright, Doyle, O'Brien and Phillips.

Mr. Morrison presented a communication from John T. Campbell, of Rockville, in which Mr. Campbell expressed his regret at not being able to attend the meetings of the Society, and manifested his interest in its welfare by sending his paper on "Appealed Survey in Vigo County," to be read by a member of the Society. On motion of a member, Mr. Morrison was requested to read Mr. Campbell's paper, which he accordingly did.

James H. Smart, President of Purdue University, being present, was invited to address the Society. He spoke as follows :

"Ladies and Gentlemen—I am glad to be with you this morning and to repeat the cordial welcome which was given to you yesterday by Prof. Coulter. It was a source of pleasure to me to have the invitation to attend this meeting come from a son of one of the best friends that I ever had—Prof. John I. Morrison. I used to say, and I still think, that Prof.

Morrison did more for education in Indiana than almost any other man of his day. I am sure that the memory that he left behind him is precious to all who knew him.

“ You will expect me to say something about Purdue University. As you all know, we have a School of Civil Engineering. The course is well arranged, and we are fairly well equipped with apparatus. I am glad to know that we have your good-will and sympathy. The field of civil engineering has widened so very rapidly in the last few years that schools for instruction are multiplying all over the country, and it is our purpose to have one in Indiana that shall be second to none. We expect to turn out railroad engineers, bridge engineers, hydraulic and sanitary engineers. While we expect to turn out civil engineers, we do not expect them to become rivals of those who hold political appointments; most of them will drift to the large cities and engage in work as specialists. The civil engineer has no need to fear too much education. It used to be feared that technical schools would create too much competition, but I think this will not be the result. The competition which a man needs to fear is that which comes from a man who does second-class work at a second-class price. Skillful men have no need to fear the man who will do a first-class job at a first-class price. Moreover, the technical school is chiefly for the sons of the industrial classes. We are training *your* sons, and I pity the man who is afraid of the competition of his own son. If your son can make a better engineer than you have been you ought to be glad of it.

“As to our plan of work, I will say that it is our purpose to give our men a good academic education as a foundation for their specialties. As a further foundation for the technical work, we make our men good mechanics. We are sometimes asked why we do not teach men to become type-setters, and so on. Well, we are trying to make engineers, and wood and iron are the two things that are used more than all others in construction. You may ask, “ How is your plan working? ” Of course, we think it works well. Our students spend as much

time in study as in the ordinary college ; in addition to this, they spend two hours per day in the shops for a period of two years, making in all, seven hundred and twenty hours, and in this time they become good carpenters, good blacksmiths and good machinists, and can do a first-class job in these departments. We have discovered that the man who does the best work in the shop, is the one who does the best work in his ordinary studies.

“ It is sometimes said that the technical school is a failure, because it does not produce inventors. I think you will agree with me when I say that it is a difficult thing to invent a bridge. Bridges that were built a thousand years ago, still stand, and are doing good service. We do not expect to send men out who will build better bridges than were built a hundred years ago, but the new man must build a good bridge at a less expense. Twenty-five years ago a bridge was built over a certain river for two million dollars ; to-day, a bridge can be built that will do the same service for one-half that amount of money. Our purpose is to turn out men who will do the best kind of work at the least possible expense. I have been asked if it is not true that some of the best engineers that we ever had were men who were not educated in a college. I am obliged to say, yes ; and yet it is true that a college education, if properly given, is a good thing. While we can not make a thousand dollar man out of a ten cent boy, we do claim that we have an institution that is working in the right direction ; an institution that can do the boys who wish to become civil engineers good, and we are very glad to have you here to inspect Purdue University and tell us what you think of it. We will give you an opportunity of seeing just what we are doing, and how we are doing it, if you can afford the time to take it in. If there is anything that you want that you do not see, let me know, and I will try to get it for you.

“ I trust that your meeting here, will be both pleasant and profitable to you, and I am sure it will be to us. I again express my gratification that you decided to meet here at Purdue.”

On account of the absence of Prof. J. L. Campbell, the subject of "Kankakee Drainage," was deferred until the evening session.

The Society then adjourned, to meet at the Court House in the evening.

EVENING SESSION.

WEDNESDAY, January 13, 1892.

The Society met at the usual hour, President Phillips in the chair.

The subject of "Kankakee Drainage" was presented by Mr. Whitten, engineer in charge of the State work in the Kankakee region, in connection with which Mr. J. L. Clark, Vice-President of the Illinois Society of Engineers and Surveyors, read an article descriptive of his method of reclaiming that part of the Kankakee marsh known as the "Cass Farm," near Momence, Illinois.

J. E. Alter, of Rensselaer, amused the Society for a half hour by giving in dialect a description of "The Joys and Sorrows of the Drainage Engineer."

Mr. O'Brien, of the Committee on Necrology, presented resolutions relative to the death of R. H. Walls, late President of the Society, which were adopted, and asked for and extension of time as to Mr. Truitt, which extension was granted by vote of the Society, and the committee continued.

A motion was made to appoint a Committee on Program, and require the same to report before the end of the session.

The motion was supported by Messrs O'Brien and Smith, and opposed by Messrs. Wright, Goss, and others.

Mr. Alter moved that the Executive Committee be instructed to prepare the program for the next meeting, have it printed and sent to each member of the Society three months before the next annual meeting.

The motion prevailed.

An invitation was tendered the Society by the engineer of the LaFayette Bridge Works to visit their shops, offering free transportation, and a number of members availed themselves of the offer and visited the works the following morning.

A motion to adjourn prevailed.

MORNING SESSION.

THURSDAY, Jan. 14, 1892.

President Phillips announced the following standing committees for the ensuing year :

ON LEGISLATION.

Wm. M. Whitten. J. R. Brown. Prof. J. L. Campbell.

ON DRAINAGE.

Wm. M. Whitten. J. E. Alter. John P. Doyle.

ON ENGINEERING AND SURVEYING.

Prof. M. J. McCue. N. A. Beck. C. G. H. Goss.

ON PUBLIC HIGHWAYS AND BRIDGES.

J. O. Wright. Wallace Marshall. Craven Smith.

ON INSTRUMENTS, BLANKS AND RECORDS.

E. B. Vawter. J. C. Teeters. Wm. M. Whitten.

ON STATISTICS.

L. S. Alter. R. I. Morrison. J. F. O'Brien.

ON COMPILING AND PUBLISHING REPORT.

W. P. Carmichael. J. R. Brown. Everett B. Vawter.

Everett B. Vawter read a paper entitled, "Some Qualifications of the Engineer," which was discussed by President Smart, of Purdue University.

Prof. A. E. Phillips gave an example of computing strains in bridge trusses with parallel chords, by means of graphics, claiming that for the engineer unskilled in analytical work the method was best, being easily mastered and sufficiently accurate for general purposes.

The report of the Committee on Instruments and Blanks was presented and approved.

The report of the Legislative Committee was presented by Mr. Alter, and approved after discussion by Messrs. Fatout, Alter, Whitten, Phillips, Wright and Carmichael.

The report of Special Committee on Increased Interest was adopted, and the committee discharged.

The report of the Recording Secretary was presented by Mr. J. R. Brown, and approved by the Society.

The report of the Treasurer was presented by Mr. H. B. Fatout, and approved.

The report of the Corresponding Secretary was presented by Mr. G. M. Cheney, and, on motion of Mr. Wright, was received.

On motion of Mr. Alter, the bills presented by the Recording and Corresponding Secretaries for expenses incurred, were referred to the Executive Committee, with power to act.

The Chair announced that the Society would proceed to the election of officers.

Mr. Fatout moved that the present set of officers be continued until the proposed new constitution is adopted.

Mr. Morrison raised the point of order that the motion was unconstitutional, and the Chair ruled the point well taken.

Mr. L. S. Alter moved to re-elect the old officers by acclamation, and Mr. Morrison raised the point of order that the motion was unconstitutional, the law providing that the officers be elected by *ballot*.

Mr. Fatout moved that J. R. Brown, the ex-Recording Secretary, be instructed to cast the ballot for the present officers for the ensuing year.

The motion prevailed, and Mr. Brown accordingly cast the vote of the Society as follows:

For President, A. E. Phillips.

For Vice-President, J. F. O'Brien.

For Recording Secretary, W. P. Carmichael.

For Corresponding Secretary, E. B. Vawter.

The Chair called for nominations for members of the Executive Committee.

Mr. Wm. Whitten was placed in nomination by Mr. Goss; Mr. Morrison, by Mr. Alter, and Mr. Fatout by Mr. O'Brien.

Mr. Goss moved that the Secretary be instructed to cast the vote of the Society for the three nominees, which was concurred in, and the Secretary cast the vote for Wm. M. Whitten, R. I. Morrison, H. B. Fatout, for members of the Executive Committee.

Mr. Duncan extended an invitation for the Society to hold its next annual meeting at Bedford, among the stone quarries.

Prof. McCue invited the Society to hold its next meeting at South Bend, and the invitation was seconded by Mr. Whitten and others.

Prof. Phillips said that Purdue would always welcome the Society, but no invitation had been given because it was supposed that other places would want the Society to visit them.

Mr. Alter suggested that possibly a joint meeting with the Michigan Engineering Society could be arranged if the Society should meet at South Bend.

On motion, the matter of selecting a place for the next meeting was referred to the Executive Committee.

A vote of thanks was given Purdue University for courtesies shown the Society during the meeting.

Prof. Phillips responded for the University, and, on motion of Mr. Morrison, the Society adjourned *sine die*.

RECORDING SECRETARY'S REPORT.

To the President and Members of the Indiana Engineering Society:

Gentlemen—Your Recording Secretary and *ex officio* chairman of the committee to compile and publish the annual reports of the transactions of the Society, respectfully reports that the minutes and manuscripts of the papers read at our last annual meeting in January, 1891, were arranged and placed in the hands of the printer for publication in June last; that he was assisted by Professor Jacob Norris, of Wabash College, in the revision of manuscripts and arrangement of the material making up the reports; that President Morrison, who solicited and procured advertisements to the amount of \$120.00, made a contract with W. B. Burford, of Indianapolis, for printing the reports, and that the collections on the advertisements and the paying for the printing of the reports were also attended to by Mr. Morrison.

During the last meeting he received for annual dues and membership fees the sum of \$46.00, and the sum of \$13.75, contributed by a number of generous-hearted members present, toward paying the balance on printing bill, making the total amount received, \$59.75; that the Society owed, according to Treasurer Morrison's Report, a balance of \$65.00 to Wilson & Humphreys for printing the reports; that, according to Treasurer Fatout's directions, he paid the amount received, \$59.75, to the said Wilson & Humphreys, and that, in addition to the amount collected, he paid out of his own pocket \$5.25 to said printers, in order to pay the full amount of the balance due; that, in October last, he received of Hiram Burner, \$2.50 on dues, which would leave due yet on the printing claim from the Society to the Secretary, \$2.75, and, in addition to this, the expenses incurred for car fare and hotel bills in the publication of the reports of 1890 and 1891, a bill of which he files herewith, asking you to allow the same, to re-imburse him for his necessary expenses while in the discharge of his duty on the annual report of the Society.

Respectfully submitted,

J. R. BROWN,

Recording Secretary.

TREASURER'S REPORT.

Gentlemen of the Indiana Engineering Society:

Your treasurer begs leave to submit the following report :

Received from Recording Secretary	
Brown, from dues, etc	\$59 75
Received from Printing Committee,	
on account of advertising	120 00
Total	\$179 75
Paid Printing Committee for print-	
ing reports	179 75
Balance in treasury	. . .
Respectfully submitted,	
	HENRY B. FATOUT,
	<i>Treasurer.</i>

**REPORT OF COMMITTEE ON INSTRUMENTS, BLANKS
AND RECORDS.**

To the Officers and Members of the Indiana Engineering Society:

Gentlemen—Your committee beg leave to report that while they have made no extended inquiry into new or improved makes of instruments, yet a few have come under their notice that are worthy of mention.

The well-known firm of Keuffel & Esser is represented at our meeting by Rudolph Link, with a full line of their instruments of precision and drawing instruments. One thing is noticeable about the transits and levels, and that is the fact that they are all fitted with stadia wires, showing that the method of taking distances by means of stadia measurement is becoming more popular. An improved form of target for leveling-rods is exhibited that is certainly an excellent device, enabling the instrument man to keep the rod in a vertical position, thus eliminating one of the chief sources of err

the leveler. We also noticed an improvement in scales, the graduated face being white (celluloid) with black lines. The trigonometer is an excellent and convenient instrument for the topographer or engineer engaged in making triangulation surveys. The engineer's slide-rule facilitates computations of all kinds, and is coming into more general use. The polar planimeter can be of great service to the engineer or surveyor in measuring areas of irregular perimeter, such as cross-sections of earth-work with irregular surface. The aneroid barometer would enable the engineer at all times to use sea level as his datum for comparison of elevations, instead of assuming a datum at random, as is oftenest done. The barometer can also be used in determining with approximate accuracy the relative elevation of different places.

Keuffel & Esser have lately introduced a novelty in the line of drawing paper that is excellent in its line, being sheets of drawing paper of convenient size, with the edges graduated to different scales, and to degrees and half degrees, having a small cross to mark the center. By the aid of parallel rulers angles of any degree may be measured, and from the scales on the edges, plans may be sketched with great rapidity.

The committee would also call the attention of the members of the Society to the splendid line of engineering instruments on exhibition belonging to Purdue University. A careful inspection of these instruments can not fail of being instructive in the refinement of instrument making. Buff & Berger, Fauth & Co., Gurley, Holmes, and other well-known firms are represented, and the University is to be congratulated on the excellence of its equipment.

As to blanks, the committee has nothing new to report. We think the records of all work should be complete and as minute as possible in the preservation of data. For surveyors' (county) records, the most approved plan is to make a plat showing bearing of all lines, their length, natural objects of prominence, monuments, witnesses and a full description of field work.

G. M. CHENEY,
Chairman.

**REPORT OF COMMITTEE ON PUBLIC HIGHWAYS AND
BRIDGES.**

To the Officers and Members of the Indiana Engineering Society :

Gentlemen—Your Committee on Public Highways and Bridges beg leave to submit the following report :

During the year the committee has held no meeting and there are but two members now in this city. Mr. Brown, of this committee, will submit a paper on the subject of highway improvement. We have also learned, since arriving in this city, that our worthy Secretary, Mr. Carmichael, is thoroughly posted, and has some very practical ideas on the subject of our road laws, but could not induce him to reduce them to writing; but, if the Society will call him out he can, if he will, give us a very instructive talk on the subject, and perhaps the Printing Committee can prevail upon him to furnish the substance of his remarks, reduced to writing, for insertion in the proceedings of the Society.

The subject of the improvement of highways is now receiving much attention throughout the entire country. Governors of States are taking part in its discussion and making recommendations on the subject to State Legislatures; societies are formed for the express purpose of creating public sentiment in favor of better roads; engineering societies of the highest standing are discussing the best methods for improving common roads, and the press is doing good work in awakening public interest in the matter.

In some of the recent newspaper articles, the roads of this country have been compared with those of Europe, with the intimation that, inasmuch as the latter were better than the former, it would be necessary to import foreign talent to teach us how to make roads. Now against this insinuation we most respectfully, but earnestly, protest, and venture the assertion, that no country in Europe, during the first or second century after its settlement by civilized man, could show better roads than can be found in this country to-day, and also the prediction that when civilization in America has reached

one-half the age which it has now attained in those countries, our roads will equal or surpass those now in Europe. It is not because engineers do not know how to construct roads, that our highways are in no better condition. They understand the requirements of road-making far better than they have opportunity to put their knowledge into practice. Every engineer and surveyor in the State knows that a great portion of the labor and money expended on highways is a total loss, and in many cases an absolute damage to the roads; but of what use is this knowledge to him or to the public, so long as he has no control over the construction and repair of highways?

Instead of being placed in the hands of persons of knowledge and skill in road making, our roads, for the most part, are in the hands of unskillful persons, whose chief recommendations for the position, too frequently are that they are the only ones to be found in their respective road districts who will accept the office.

Their pay is small but, too often, far above the real value of their services, and for fear they will do too much, the time they are allowed to work the roads is limited by law.

The Road Supervisor is the only office which a free-born American citizen can not refuse without subjecting himself to a fine. The truth is, our general road laws must be radically changed before our highways can be greatly improved. Our common roads must be placed in the hands of competent superintendents, who must be provided with sufficient funds to construct them properly and keep them in repair.

The subject of material for street pavements may properly be considered in connection with highway improvements. At present this is a subject of considerable interest to municipal engineers. The Chairman of this committee has great faith in vitrified brick as the coming material for this purpose. During the past year he has had tested at Purdue University, samples of brick that stood a crushing test of nearly 22,000 pounds per square inch. This you will notice is more than double the usual strength of granite, which is usually con-

sidered the most durable material for pavements. If the manufacture of paving brick were in the hands of a monopoly with energy and capital to push it on its merits, as other material for pavements are now handled, brick would soon come into very general use.

The City of South Bend has four blocks of brick pavement, two of which have now been down two years on one of the principal streets, and show no signs of wear. Two blocks were laid down in 1891, with a single course of brick set on edge on a foundation of thoroughly rolled gravel with the usual cushion-coat of sand between. Many doubts were expressed as to the sufficiency of this foundation, until after the work was done, but since that time, it is almost universally conceded to be an entire success. In the opinion of the City Engineer it is fully equal to, or better, than the foundation under the first two blocks, which were laid in the city, which were laid on the usual two course plan, and at a cost of about \$1.05 per yard, as against \$1.54 per yard for the double course. The courses of brick were laid at an angle of 45° instead of at right angles with the street, as is usually done. This was done for the same reason that bridge plank are often placed at an angle with the line of traffic.

With respect to highway bridges, the committee can only say that the conditions of highway bridge construction are slightly in favor of a better class of bridges than was possible a few years ago. In some instances County Commissioners, in whose hands bridge erection usually rests in our State, have employed competent engineers to prepare plans, specifications and estimates for the structures they propose to build, and the result has been beneficial in a two-fold sense: it has lessened the cost by rendering difficult or impossible the abominable practice of "pooling" that is so common among bridge agents, and has secured a structure that is strong in details as well as in strain-sheet. Iron and steel are the almost universal materials for bridge construction except in the floor systems, and even there I-beams will ere long supplant wood for joist, and concrete floors, supported by brick or metal

arches, plank for wearing surface. As the demand for heavy bridges increases with the ever increasing maximum loads, we may, before long, see highway bridges figured for concentrated wheel loads, instead of uniformly distributed panel loads, as is now the custom. A few years ago Waddell set a mark for bridge engineers to come to, that bridge *agents* (not engineers) hooted at as being impracticable because too heavy and not economical, but not many years will elapse until the wisdom of Waddell's tables will receive vindication at the hands of bridge designers who plan for and anticipate the heavy traffic of the future.

WM. M. WHITTEN,

J. R. BROWN,

Committee.

DISCUSSION ON REPORT OF COMMITTEE ON HIGHWAYS AND BRIDGES.

Mr. Carmichael—I think that Mr. Whitten has treated me rather unfairly by violating the confidence that I placed in him when I unbosomed myself to him touching the road question. I did not intend that he should make public what I said, nor that I said anything; but since he has done so, I will try to give my impressions on the question of improving our common roads, in a general way, as a supplement to the excellent report of the committee, to which you have just listened. Common roads are to country districts what railroads are to towns and cities, and the commercial prosperity of a district is greatly enhanced by good roads or hindered by bad roads. Good roads bring and keep the farmer and his family into touch with the civilization of the larger world that lies beyond their horizon, so that they get by a process of absorption that comes from contact, something of the elements of progress, of prosperity, of culture and refinement of heart and intellect that belong to the dwellers of communities where social and commercial intercourse is unhindered and easy.

Bad roads are always expensive. What a wonderful contrast is made by a comparison of the cost of transporting the products of the farm to the railway station, only a few miles distant, and from the railway station to the seaboard, a thousand miles away! Oftentimes it costs more to haul a ton of merchandise a mile over an unimproved public highway, than to haul it a hundred and fifty times as far on the railway, which is an *improved* highway. But that is not all. Oftentimes the condition of the common roads is such that it is absolutely impossible to haul any load at any price. The condition of the roads in the country districts just now is bad in the extreme. In many localities the farmer can not market his produce at any cost, and if he were offered one dollar a bushel for his corn it would do him no good, for he could not haul it to market. A case in point is this: During the month of November and early December corn was worth from forty-three to forty-five cents a bushel in the local market—a good price, far above the average—and many farmers would gladly have sold had it been possible to haul their grain to market, but at the time the good prices prevailed the common roads were quite impassable for heavy loads, and the farmer could not sell. The present price of corn is fully ten cents a bushel under the early December prices, and the farmer who had 1,000 bushels to sell, lost by reason of the bad roads, a sum sufficient to pay a tax of one dollar and twenty-five cents an acre on eighty acres of land. A change in the system of building roads is necessary beyond question, but the chief opposition to such a change comes from the persons benefited most by good roads—I mean the farmers—and by reason of that opposition, no Legislature has as yet had the courage to institute reforms. Farmers fail to realize the extent of the loss they sustain by a lack of good roads—roads that can be depended upon in the rainy months of February and March, as well as in August and September. Nor is that loss always to be estimated in dollars and cents—the standard by which we are too apt to measure values. There is a direct financial loss, it is true, that comes from a lack of good roads in various

ways, such as the enormous loss in time in going to and from town; the loss from worry and over-exertion to horses and all draft animals, resulting in shortened lives and limited periods of greatest usefulness; the loss in added wear and strain upon vehicles of all kinds; the loss that comes in the shape of diminished loads; the loss, as I have shown, in inability to take advantage of the most favorable markets—all these mean a direct and absolute loss of money, that would astonish the objecting farmer could he know the amount—but there is a loss of those things that go far toward making the farmer's life worth living, the value of which is too great to be measured by the standard of lucre. Man's social nature is strong, and demands sustenance that is gotten from intercourse with his fellows. Deny him this sustenance, and he becomes narrow, selfish, morbid. Social intercourse adds immeasurably to man's capacity for enjoying the good things of this life, and contact with his fellows broadens him in character and makes him a more useful member of society. Each town or village is the intellectual and social center of the neighborhood around, and when the people can readily reach these centers they are improved in mind and manner, by coming into touch with an intelligence and culture that in turn comes from the larger towns and cities. By bad roads this commingling of country and town is prevented, or rendered difficult. Again, the loss becomes a financial one, for viewed in the light of the broadest economy, an intelligent, well informed citizen is worth more to the State than a denizen of the back-woods or hills, who never sees a train of cars nor reads a newspaper.

At times, in case of accidents or of sudden sickness, bad roads may mean loss of life or great suffering.

Granted, the proposition that we need better roads, that economy and the greatest good of mankind demand them, how are we going to set about to get them? Clearly the way to an improved system of highways lies in legislation. Education of public sentiment must precede legislation—that is the way of all reforms. The present system must be shown up in its true light, as a wasteful, antiquated, unbusiness like

method of dealing with one of the most vital parts of our social machine. Few people have even the faintest comprehension of the enormity of the waste of public funds through the so-called road system that prevails in our own and many other States—a custom borrowed (inherited) from the old world more than a century ago and long since discarded by them as unworthy civilized nations. In my own county of Warren—less than an average county in population and wealth—we raise annually by taxation for road purposes (common roads) about \$21,000, including the property tax and a per capita or poll tax of about \$5,000. Of that sum \$2,300 goes to pay the forty-six road supervisors and \$1,200 to pay the twelve township trustees for what they do upon the roads. There are thirty-six road machines in the county that cost on an average of \$200 each, making \$7,200 invested in graders, and when the cost of plows, scrapers and other tools is added, we have an aggregate of \$8,000 invested in machinery. This machinery has to be renewed once in about every five years, making the annual cost, including interest on the money invested, about \$2,000. When the cost of collecting the tax is added to the items named above, we have a total cost of administration of \$6,000, leaving \$15,000 to be spent upon the 700 or more miles of common roads. Just think of spending nearly 30 per cent. of the money raised for road purposes, to pay the officers and buy expensive and oftentimes useless machinery. Is not there need of reform? But that is not all, for of the remaining \$15,000 probably not more than 10 per cent. is spent intelligently and for the permanent improvement of the highways. Fully \$18,000 is wasted each year in our little county—a sum sufficient to capitalize \$300,000 at 6 per cent., or \$360,000 at 5 per cent. annual interest, with which such a start could be made toward improving the roads that, without increasing the burden of taxation, within a few years every main road in the county could be graveled or macadamized. What is true of our county is true of every county in the State of Indiana. What more pressing need for reform could exist? It is true that we can improve our roads

now under the special gravel road laws, but the remedy is only partial, and does not strike at the root of the evil. Better wipe out the entire system of laws and begin anew, than allow the present wasteful practices to continue, for entirely new laws could hardly be worse than those that now are upon our statute books. The present system of building permanent roads while far better than no system, and to which we owe what little we have in the way of good roads, is objectionable because the cost is inequitably distributed, falling too heavily upon the lands immediately adjacent to the line. While it is true that the lands bordering on an improved road undergo an increase both in salable and rental value that more than offsets that portion of cost of construction set off to them—ten-fold in many instances—yet there is a reflective benefit that results to the entire community, county or State, and a portion of the cost of constructing permanent roads should be borne by the State at large, a portion by the county and the remainder—larger than one-half—by the adjacent lands. Probably the work of construction should be left under the control of the State, for State officers would be less likely to be influenced by local considerations. The best roads in the world are the State roads of France, which were constructed and are maintained by the State through well trained engineers, thoroughly educated in the science and practice of road-making.

But the subject is almost inexhaustible, and your time and patience, finite. If you will bear with me for a few minutes, I will give you a sketch of, not the ideal road, but such a road as may become common throughout our State, and such as is entirely practicable under present conditions—indeed we have built and are now building such roads in Warren county. I do not expect your approval on all points, but hope that my errors may be useful by provoking discussion.

The three important factors that go to make a good road are: (1) Alignment and selection of the best route; (2) Making a good road-bed with proper grades and drainage, and (3) care in the selection and distribution of the covering of gravel or

stone. These three elements constitute the "trinity of the gospel" of good roads; they are one and inseparable. The neglect of one will, in a greater or less degree, impair the success of the work, and it is only by careful, conscientious attention to these elements, both in design and execution, that a good road can be constructed. The order given is not one of relative importance, for it is difficult to determine which of the factors named contributes most to the success of road-making, but because that is the order followed in construction.

The selection of a route for a highway, in our portion of the country, would seem a very simple problem, namely, the location of the section or subdivision line, but the time is coming when roads will be located, as they ought to be, on the lines of the greatest travel and most economical construction. In former times that principle was observed in the location of roads. The towns or mill-seats that furnished the nuclei of the widely separated settlements were connected by roads that were as nearly upon the shortest practicable route as possible, and to-day, where the roads have been allowed to remain as they were originally located and the conditions of commerce and population have not changed, those old diagonal roads are most traveled. I believe the public fails to realize the magnitude of the mistake that is made in wrong location of roads. Where the conditions demand it, I believe, the proper location of a road is upon the land or section lines, and I would even strain a point to locate a road there if it were not at too great a sacrifice of distance or cost; but to throw aside all considerations of economy in distance or cost, and locate a road on a section line, is a serious error. To illustrate, I will suppose a case: From Elm Grove Church, in Liberty township, Warren county, to the Stearns corner, the Keys gravel road forms a diagonal with the section lines, running approximately from northwest to southeast. The measured distance along the road, between the points named is seven-tenths of a mile. Following the section lines the distance is one and two-tenths of a mile or five-tenths of a mile greater than

on the road. Suppose Messrs. McCabe and Smith, the owners of the land traversed by the road, were to petition the County Commissioners to change the location of this road from its present route to the section lines, and succeed in their undertaking, what would be the cost to the traveling public? A conservative estimate would place the number of teams passing the church, going one way, at 100 daily, or 200 both ways. Each one of these teams, by reason of the change secured by Messrs. Smith and McCabe, would travel an additional half-mile, or an additional 100 miles by all of the teams. In one year the extra mileage would amount to 31,200 miles, not counting Sundays. Assuming that the cost of traveling one mile, with a two-horse team, loaded, is ten cents, or that the cost to all kinds of teams, loaded or not loaded, and single or double, is six cents, we have a minimum annual cost to the public of \$1,872 for only seven-tenths of a mile—more than enough to build that much first-class gravel road and pay sixty dollars an acre for the land. And who is benefited by the change? *Two landholders* in a very small degree.

The route selected for the main roads should be the most direct that can be constructed economically. Lateral or neighborhood roads may be located on land lines when the cost is not too great. The location of roads may often be made with reference to the location of the gravel pit or the rock quarry, but too much stress should not be given this point, for a road is a permanent institution and it may in the end be cheaper to haul the material further than to lengthen the road in order to reach the material or save a small distance in the haul. I am aware that what I have said on the question of location is not popular, but I believe, nevertheless, that it is true.

Grades form an important part in road construction. "A chain is no stronger than its weakest link and a road is no better than is steepest grade or worst place." By that I mean that the maximum load is determined by the steepest grade, and probably the most important object to be attained in constructing a road is to render it possible to haul the greatest possible load at the least possible cost. In the prairie

portions of our county, where I have been employed in constructing roads, I have made 1 in 25 the maximum or steepest gradient, and, if it were possible to do so without increasing the cost beyond the economical limit, I would make that the rule; but there are localities in which 1 in 16 is the lightest grade possible. It is not advisable, I think, under any consideration of economy, to build a road with a steeper grade than that, for the maximum load is then reduced to that of unimproved or dirt roads. A perfectly level road for a long distance is not desirable, because of difficulty in drainage.

The cross-section of the road-bed will depend entirely on local consideration of grades, soil, natural drainage and anticipated demands in the way of traffic. In general, the sub-grade should be above the natural surface, except in excavation. On ordinary level or approximately level roads the elevation of the road-bed should be about .75 foot or 9 inches. The earth taken from the open side-drains will make this if the road-bed does not exceed 24 feet in width. In marshes or low, flat ground, this height should be increased to suit the circumstances.

The surface of the road-bed on which the covering of gravel or stone is to be placed, should vary according to the character of that covering. For gravel, I would make it flat or level in cross-section to the full width of the metal covering, with a slope of, say, one in ten to the edge of the side-drain. A slight convexity can be given the gravel, sufficient to shed water. For Macadam or broken stone roads, the covering should be of uniform thickness, thus requiring the sub-grade to be the arc of a circle whose radius could be changed for different grades. Where the grade is light, the radius should be shortened, and on steep grades, it should be lengthened, thus making the convexity of the road vary with the conditions of water-shed. Thorough drainage is the *sine qua non* of good roads. The water must be kept off the top, and to accomplish that object the covering of gravel or stone is put on. But to what purpose, if the water from the top is permitted to lie along the side and be absorbed

by the porous earth of the road-bed. Before we go to the expense of covering the road-bed with metal, we must take the water from the sides and from beneath. Open drains should be constructed on each side of the road, varying in depth according to the amount of water to be carried away, the character of the soil, and the necessities arising from securing grades or "fall." These drains should in no case be less than eighteen inches deep, measuring from the sub-grade. In low ground the depth should be at least twenty-four inches, and the outlet for the water such that it would never be allowed to accumulate or stand in the ditches, for by capillary attraction, it will be drawn up into the road-bed and the more porous lower courses of gravel or stone. So much for the water that comes from the surface. But fully as damaging to the permanency of the work is the water that comes from springs or water-beds that lie beneath the road, and to prevent this water from reaching the gravel or its bed, tile drains should be laid parallel with the center line of the road, under one edge of the gravel, so that it can be reached in case repairs are needed without damaging the covering, and to a depth slightly below the bottom of the open drain. The size of this drain will depend upon the distance to the outlet, but it seldom need exceed five inches, and it will save its cost many times over, by lessening the repair bill. A well-drained road will not "heave" and cut up at this time of year, as we see our gravel roads now. Culverts or cross-drains should be provided at such points as may be necessary, to permit the water to flow off readily and freely. Standard sewer-pipe or culvert-pipe with ends well protected by walls of stone or brick, make the best small culverts, while for the larger or more important ones stone should be used.

With easy grades, a good road-bed, and thorough drainage, we are warranted in going ahead and completing our road by putting on the roof—for the covering of gravel or stone acts as a roof to shed the water from the porous earth beneath as well as to furnish a wearing surface. The character of this roof or covering will depend entirely upon the import-

ance of the road, and consequently the amount of money that can be raised to build it. In cities, granite blocks and asphalt furnish respectively the most durable and the smoothest pavement, while brick, vitrified, or partially so, is in great favor at present; but with the exception of brick, none of these materials are available for suburban or country roads. Brick, I believe, can be used in country roads where the country is wealthy, and the road important, for a brick roadway twelve feet wide, with a gravel or sand foundation, can be built for \$6,500 to \$8,000 per mile, and with concrete foundation, for \$10,000 a mile. But at present it is out of the question to consider the expenditure of such a sum on a mile of road. Macadam and Telford roads come next, and both can be constructed in our State out of the drift boulders that lie scattered in such profusion over that portion of the country lying within the limits of the morains, or from the vast stores of limestone and trap found in some localities, and, in some instances, at a cost less than that of a gravel road. The systems of road building known as Macadam and Telford are similar, and derive their names from the two great engineers, Macadam and Telford, who revolutionized road-building, and gave to England the magnificent roads that are found everywhere on that picturesque island. Macadam made his roads by breaking trap-rock, limestone or granite into cubes or fragments, not exceeding two inches in greatest diameter, spreading them on the prepared and drained road-bed to a depth of from four inches to sixteen inches, and compacting the cubes by ramming or by weight of vehicles, until a monolith, practically, was formed, entirely impervious to water, and stable enough to resist the heaviest vehicles.

In late years Macadam roads have been compacted at once by the use of heavy steam rollers, designed especially for that purpose. Telford roads differ from Macadam in that the lower course of stone is formed from larger stones set on end and hammered into position by hand. The interstices are then filled with smaller stone until the top layers are like those of

Macadam roads, being compacted in similar manner. The Telford roads are more expensive by reason of the lower courses being set by hand, but they are more durable. In many cases single miles of Macadam road can be built in my own county for an expense not exceeding \$2,000 per mile. Six inches of Macadam spread to a width of twelve or fourteen feet on a compact surface, and well rolled, is more durable, and will cost less for repairs than ten or twelve inches of gravel. By transporting limestone from Delphi or Logansport, we could build roads three miles from the railway stations for \$2,000 a mile, if the railway company would haul the stone for a nominal sum per car, as they have in the past proposed to do. Assuming that the freight would not exceed \$5.00 per car, the cost of transportation for a nine-inch covering twelve feet wide, would be about \$900 per mile. Allowing for all contingencies, we can build roads of broken stone from Delphi for \$3,000 per mile, and have a covering that is as far superior to gravel as gravel is to common earth roads. But the material that is most abundant in our State, and that will for many years to come be the only material used in constructing our improved roads, is gravel, which, after all, is Macadam in principle, namely, furnishing, in a limited degree, a covering for the road-bed that is impervious to water, and will withstand the wear of wagon wheels. In the hills bordering the Wabash or its tributaries, are vast stores of the very best of gravel, while drifted into mounds or dropped into the valleys of the more level portions, are inexhaustible supplies, only waiting for the coming of enterprise to be put to a useful purpose. The under limit of quantity of gravel is one cubic yard per lineal yard of road, or 1,760 cubic yards per mile, but 1,955 cubic yards is the least quantity that is used on roads constructed under the different petition laws, and 2,400 cubic yards is preferable. The material used should be as free from earthy matter as possible. The natural slack of the limestone, that is so abundant in our gravel, will furnish compacting or cementing material enough in most cases. Earth in considerable quantities must always be avoided, be-

cause it furnishes an absorbent for water, which is, in all cases, detrimental to the solidity or durability of gravel roads. The width to which gravel should be spread will depend upon the quantity used per mile, but it should never be applied to a less width than ten feet, and in most cases twelve feet. In the former case it will spread to twelve or thirteen feet, and in the latter, to fourteen or sixteen feet. For ordinary county roads, that is sufficient. When completed, a gravel road should never be opened for heavy traffic until it has been well compacted by rolling or by rains and lighter vehicles, for great damage is often done a new road by hauling heavy loads over it while it is "green." Many persons advocate building double-track roads, that is, making a track for summer travel on the natural earth, parallel with and adjoining the graveled portion. While this plan has many things to commend it, it has one disadvantage that is a serious one. One great source of expense in repair to gravel roads is the damage that is done by mixing earth from the side of the road with the gravel, thus making a mixture that will hold water and "cut up." Now if the summer track lies immediately adjacent to the metaled track the earth and gravel will become mixed, so that great damage will befall the road. This objection might be obviated by having a small drain between the two, or a space of say two feet in width sodded.

Permanent gravel roads, such as I have described, can be constructed for from \$1,000 to \$3,500 per mile, the cost varying with the conditions of topography, location of gravel and length of haul, cost of labor, etc., but, in my county, \$1,500 is probably the mean cost per mile. Last year, we built one road of nine and six-tenths miles, with an average haul of seven-tenths miles, using 1,955 cubic yards of gravel per mile, for \$10,200, exclusive of superintendence and interest on bonds. We have now under contract eight miles of road, with an average haul of two and two-tenths miles and 2,200 cubic yards of gravel to the mile, for \$1,800 per mile.

My remarks, so far, have had reference only to improved roads. Aside from the application of the gravel covering, the

construction of common or earth roads should follow the same plan. For most of earth roads, drainage is the only thing that can be done aside from grading and providing the necessary culverts. Country roads could be greatly improved by an intelligently planned and thorough system of open and under drains such as I have proposed. If the water is removed from the sides and from beneath, the sun and wind will soon dry up that on top. The earth, being puddled, water does not penetrate to the lower strata, but usually comes from below. But, like poor Humpty Dumpty, all the king's horses and all the king's men can't make an earth road a good road at all times, and after the roads are drained, it would be economy to apply all of the road money toward making gravel roads. It is useless to spend time drawing the earth into the middle of the road only to be washed or tramped down again in the winter and spring. If a trustee or supervisor could only build a few hundred yards of permanent road each year, what he did would be effective and would not have to be done over again soon.

Mr. Wright—There is a subject about which there ought to be something said—a subject that demands a good deal of attention, a subject that has been agitated ever since the State was established. We always have had road laws, such as they are, and of course in the very nature of things the roads are becoming a little better every year, on account of the improvement of the country. I have a little theory of my own about that.

There is a great deal of discussion now-a-days about convict labor running against the labor organizations. The man who makes chairs does not think that the labor of the Northern Prison ought to be sold out to make chairs to be sold in competition with free labor, and it is the same with the barrel maker, and the shoemaker. Many think that this is an injustice to the laboring man.

In view of that question, the suggestion has come to my mind, might not our prisoners be located in two or three places in the State where there is an abundance of stone.

We might just as well build a stone wall around them one place as another, and put them to getting out broken stone and bridge stone and flagging stone. This work will not be in competition with the stone-mason.

At present those persons sent up by the various counties of the State are maintained at the expense of the State. Why should we not have a law allowing each county to have a credit for what stone its prisoners get out, and allow each county to draw upon the State for that amount of material, and transport it and use it?

Then take our county prisoners lodged in jail and in city calabooes, who are fed off of the people, and who are too lazy to work, and put them to utilizing this material. I think this system of convict labor should be taken up and properly studied by the statesmen that Mr. Carmichael alludes to, that we may, after awhile, overcome the system and have the convicts get out our drain tile and sewer pipe and our flagging and our rubble stone and our bridge stone for the counties and an immense amount of broken stone every year. Let an account be kept with each county and its prisoners, and if Tippecanoe, for instance, has one-tenth of all the prisoners let it have one-tenth of the material, if it chooses to take it, that is gotten out by the prisoners. I think a law of that kind would not only be made self-sustaining, but made to return quite a handsome revenue, in fact, to each of the counties. Of course the counties would have the freight to pay, but I think, very amicable arrangements could be made with the railroads. I think to get this material from this source would be that much gained, and would relieve us of a great deal of this hue and cry about convict labor, and which never amounts to a great deal except for political effect.

The Chairman—Last fall, while quail hunting, I ran across a case of repairing the roads in the country. I was rather in a hurry to get out, going out north of here. I found them trying to repair the roads, and somebody had dumped about $3\frac{1}{2}$ feet of sand in the center of the road and I had a pretty difficult time getting around it. I thought if that was a sam-

ple of road repairing, the roads are in a pretty poor condition. I think one of the best organizations that could strike this State for the improvement of the roads would be a first-class bicycle club. That has done more good in New York State and Massachusetts and Vermont and Connecticut to improve the roads than anything I have known for years. They have simply taken hold of the matter in earnest, gone into the State Legislature, and as a result, in consequence of their efforts, the roads have been improved.

Mr. Doyle—In listening to Mr. Carmichael's talk I have just one point to add to it, and that is in regard to removing all our present laws and trying to substitute something new. It seems to me that would not be the way at all. We can only build on what we have, and if we are able to better what we have all the time, it seems to me that would be doing some good. It does seem like the Legislature went backward in the law of 1885. In Benton county they are building all the roads under the law enacted that year. With the meager compensation, it is impossible to keep the superintendent of the road in the surveyor's office, and consequently the road supervisors are appointed as superintendents! You can imagine the result. No matter how well and carefully you make your specifications the average superintendent will not see one thing in a dozen therein specified. Of course I don't suppose there are any contractors in the room [laughter]. The contractor knows his business and gets along finely. The first thing the contractor does with the superintendent is to take him out over the road, and no matter if the engineer says that a certain place should be raised a foot or two, the contractor will explain that it is in the best condition now in the world to make a gravel road on, and that his judgment is just as good as the engineer's and he works a thousand dollars off the work by blarney. But if he can't convince the superintendent, he will wait until after dinner, and then explain to him again how his plan (the contractor's) was a great deal better than the specifications. Of course the engineer was very particular, and so he made it up that way.

Now, according to his judgment, that was the best; but of course his judgment is not as good as the superintendent's, but he thought it was all right, and then he tests the superintendent on his knowledge, and if the superintendent stands up against him he then takes up another test and storms and raves about the matter, and as a final test says that his men are all ready to go on with the work, and it would be such a kindness to let him go on, and unless the superintendent is a wooden or iron man he will permit the contractor to go on, and so the roads are not as they ought to be; I could tell you lots about this, but I haven't the time.

The Secretary—Before we pass from the discussion of the committee's report, we ought to have a little talk on the subject of highway bridges, to which the committee has referred. We have some gentlemen with us who not only design, but also build bridges, and I am sure that the Society would like to hear from them. I suggest that Mr. Marshall, of the LaFayette Bridge Company, give us his views on some questions of interest connected with highway bridge building.

Mr. Marshall—I understood that the subject was to be discussed in a paper by Mr. Peterson, and came rather to be informed than to give information. I am perfectly willing to discuss any particular branch of the subject, but to begin at random is a rather difficult task, especially since the subject is a broad one and I am not a trained public speaker. I can and have talked bridge for hours, but under different circumstances and with a different incentive. Possibly some of you have been afflicted by that kind of speech, not only from myself but from several other persons, as well.

A Member—Some of us know that Mr. Marshall knows how to design and build good bridges as well as to sell them. We would like his judgment as to the best bridge for short spans, say from twenty feet to sixty feet.

Mr. Marshall—On such a basis I could probably make a few remarks. I am satisfied, before I commence, that there won't be three persons in the room who will agree with me. I have had experience with engineers, but I don't know

that I ever found one who would agree with me on all of the questions connected with bridges. I don't know whether it is because *they* are so contrary or myself. If you ask me what is the best bridge for spans twenty to sixty feet, I should say steel, and for the substructure I should say stone. And yet, as a general thing, the bridges of this State are not built that way. They are usually built by the company that can put in the cheapest bridge. That is one case. The other case is the company that can get the biggest price and put in the cheapest bridge. That is usually the company that "stands in" with the county commissioners. Some people seem to think that the officers of the State of Indiana are corrupt, and that supervisors and trustees and engineers are especially so. My opinion of the engineers of the State of Indiana and of the commissioners, is that they are above that plane.

For a twenty-foot bridge, a simple I-beam bridge is the one to build; but for a bridge over thirty feet, from my experience in using I-beams, I wouldn't recommend that bridge to people who want a first-class structure. Of course, we make and sell them, but they are expensive to keep up, and eventually cause the person who builds them trouble. Of course, for a sixty-foot span, or anything below that and above thirty feet, the frame truss is the proper thing to build. I haven't any remark I wish to make on bridges that would be of any practical value to you people here. Most of you gentlemen are familiar with bridge construction in this State, and if you are not, you should be. Not as many of the engineers of the State of Indiana are as well posted on bridge business as they should be. When you come to consider that three hours, properly applied, is sufficient for any civil engineer of intelligence to figure the strains in a bridge, and then to think that fifteen or twenty per cent. of the engineers of the State can't do that, you can't help wondering. I don't suppose there is an engineer in the State but is capable, by applying himself properly for three hours, to check over any strain-sheet and see if it is correct—at least so closely

that it would be possible to read on the face of the strain-sheet that a bridge that is claimed to be 1,600 or 2,000 lbs. per lineal foot, is only forty per cent. of that, and that would be of much practical use to him wherever proposals and plans are submitted by different companies. There is one point I like to make to the engineers of the State, and that is to study the subject of bridges and learn to figure on them, at least, so they can pass intelligently on plans. I have submitted proposals a number of times in the State of Indiana when there were engineers called to pass upon plans, and who could only do it by simply looking at the elevation of the bridge, or take the word of the party who is representing the company that submits it. You want to know what you are doing before you answer. In some of our counties I find the position of the engineer depends entirely upon his own efforts, and if he will force himself upon the board of county commissioners, the time will soon come when the important matter of bridges and repairs and superstructures of his county will be turned over to his judgment, for the simple reason that he evidently knows more about it than the average county commissioner, although there are a great many commissioners who are fairly well posted. I think that is one point wherein the engineers make a mistake—simply waiting for the commissioners to call them in. They are elected for that purpose, and they should compel recognition from the board of county commissioners, and as a result, the county will get much better work, and the contractor, knowing that his work will be appreciated, will do a better class of work, and take more pride in doing good work than when he knows that the county will not appreciate a good piece of work, than where the people for whom he does the work don't know anything about it, and when he feels that he might just as well keep 15,000 or 20,000 pounds of iron out.

Mr. Morrison—The county surveyors are not pushing themselves forward in this bridge business. They should not wait for the commissioners to act, but they should suggest to

the commissioners that they should employ them to do it, and tell them how it ought to be done, and offer them plans and get them accepted. Make them do it. I think the suggestion of Mr. Marshall on that point is precisely right. Not only will there be more work done, but it will be more satisfactorily done, and the commissioners will be glad enough to be relieved of the trouble.

Mr. Carmichael—I would like to hear Mr. Marshall's opinion as to the best method of contracting for bridges.

Mr. Marshall—Well, I don't know as regards that. It has been my experience that if plans are placed on file you will get very low prices; but that is not always the case. In Indiana my experience has been that when plans are placed on file and every person is compelled to bid on those plans, they generally receive very low prices, and yet if those same plans had been in another county, and possibly in an adjoining county, it would have been the reverse. The best way to contract for a bridge, in my opinion, is to simply have the engineer and the commissioners determine what they want, and select some responsible company—some responsible contractor—and ask them what that work is worth, and it should be the province of the engineer to know whether that is too much or not enough, and make the contract and have the work put up in the best possible manner and at a reasonable price, that the contractor may be compensated for his work and the county get value received for the money that is expended. But that is not the law in Indiana. There is only one way to pursue in letting a contract in the State of Indiana, unless the commissioners take the law into their own hands.

Mr. Carmichael—I would like to ask if riveted plate girders are preferable for spans, say twenty-five to thirty-three feet, or are I-beams?

Mr. Marshall— I used to think a plate girder up to forty feet a proper bridge, and I have read many authors who so consider it, and yet in active practice for spans up to thirty feet, I find that the I-beam is just as good and possibly a little cheaper than the plate girder bridge. The principle is the

same, and of course if you don't want to consider the cost, than you can use the plate girder to fifty feet. Railroad companies in all their plans use plate girders. But that is different. You find the impact in a railroad bridge is much greater than in a highway bridge for the ordinary road. For over thirty-three feet where you use plate girders they become expensive, but probably from thirty feet to thirty-five or thirty-seven, a girder will be economical, but below thirty feet I think if you use a plate girder you must use cross-bars or wooden sills.

Mr. Carmichael—Your objections to plate girders for spans over thirty-seven feet are objections of transportation?

Mr. Marshall—Transportation is one element—cost and weight another.

The Chairman—You consider that the value of the engineer called in by the commissioners in making out his own strain-sheet and putting it on file, together with his statement of the dead and live load on the structure indispensable; wouldn't that be attended with some difficulty?

Mr. Marshall—I look at it in this way; as a matter of fact it is the proper way to proceed, and it is the law of Indiana to have it that way. But it is the rule that it is not done that way because the county engineers and county surveyors are not competent to do that work. Of course there are exceptions, but as a rule they are either not competent to do that work or else, as I have stated before, they don't force themselves on to the county commissioners. County commissioners consider that they know as much or more about it than the engineer, and for that reason they don't do it. The law says the plans and specifications shall be adopted, that strain-sheets and details and everything else shall be placed on file. But that is not the practice in Indiana, and that is the reason I urge upon the members of this Society that they insist on the board of commissioners employing them to do the work they are elected by the people to do, or, at any rate, what the law evidently intended that they should do.

A Member—I would like to ask Mr. Marshall what he thinks of the plan of buying a bridge by the pound?

Mr. Marshall—I would be hardly competent to judge those things. Every man, as a rule, looks at things from his own stand point. I would be prejudiced against bidding by the pound. It probably wouldn't be satisfactory to the bridge builders, but I think it would be very good for the county. I don't think it is done in public works except in railroad work.

Mr. Meighan—In railroad works, the engineers select the plans and invite bids per pound upon that special plan. If it is good for the railroad, it is good for the county, it seems to me.

Mr. Wright—I don't think that because it would be good for a railroad that it would be good for the county commissioners or engineers. The railroad company has a skilled engineer, and they also have facilities for having this iron tested. Now iron is not always iron—sometimes it is something else; and an iron bridge may be made of some kind of iron at so much per pound, and another quality of iron may be used by another person bidding on the same bridge. If you were to start out to buy a horse you would not buy him by the pound. It is a great deal that way in regard to a bridge. I think that would be a poor way to either buy or sell a bridge, unless you test the quality of the iron in the bridge and that is not practical on ordinary county roads.

Mr. Smith—I fully agree with Mr. Wright on the impracticability of counties adopting the system of buying bridges by the pound from the necessary lack of details on file at the time of the letting, and from the inability and want of facilities in counties to test the material and the different kinds and shapes of iron that might be used. Unless all details are complete, and then the means of testing it afterwards, it would be impossible to get bids by the pound to give any satisfaction at all. Bridge companies might submit a strain-sheet, and say they will build a bridge for so much a pound, and yet some kinds of bridge iron is worth \$30 a ton more than others. They might put in a cheap kind of iron and with very little workmanship on it. I think the plan would be entirely impracticable.

Mr. Marshall—In considering the objections to buying a bridge by the pound in my remarks I had in view only the *best* material. I don't think there have been ten bridges built in the State of Indiana in the last ten years where the materials have been tested. On the other hand, I do know of bridges having been built of nothing more or less than ordinary bar iron. I will venture the assertion that fifty per cent. of the bridges of the State of Indiana are built of common bar iron, except the plates and channels and angles. I can buy one quality about as cheap as the other. That comes again within the province of the engineer to see that the iron is tested in every bridge that is put up, and it would be a very good thing if it were invariably done. I have often been bidding on good material and other persons have bid on bad material and got the work.

Mr. Smith—I don't think that plan would give us any worse bridges than we have, but it, perhaps, would get us more expensive ones in proportion to their value than we get now. It would be very easy, and quite likely, to get in many pounds of worthless iron into a bridge. The iron wouldn't be of any value at all only to sell by the pound at a high price.

The Chairman—I take exceptions to Mr. Marshall's statement that a man learns to compute the strains of bridges inside of three hours.

Mr. Marshall—I meant the ordinary highway bridges; it is a very simple matter to compute the strains on ordinary highway bridges. On more complicated ones your statement is all right.

The Chairman—Then it requires, if treated analytically, a very great deal of time and very hard study. I advise all engineers to take up this subject of graphics. They have to deal more or less with highway bridges. There is a little book published by Green, in two parts, by which any engineer of intelligence can learn inside of twenty-four hours to calculate the strains in a bridge truss with very great ease and rapidity.

REPORT OF CHAIRMAN OF COMMITTEE ON DRAINAGE.

To the Officers and Members of the Indiana Engineering Society :

I would beg leave to report that I have done a *little* for the good of the cause—wish it had been more.

When we stop to remember that about two-thirds of the civilized world is fed from the products of the land irrigated or drained by artificial means we can begin to comprehend the immensity and importance of this subject. The most stupendous works of ancient or modern times are those made to control water and make it useful.

Water is the great destroyer of almost all engineering and architectural works.

The labor, cost and engineering skill of the fourteen to eighteen-story buildings of Chicago sink almost into insignificance, when compared to the Croton Aqueduct of New York, or the irrigating canals of the Western plains.

Even the mighty pyramids, the wonder of the world for the last forty centuries, contain but a small per cent. of the amount of material used in the levees of the Mississippi river, or the rivers of China, or even the irrigating canals of their own country, Egypt.

There is more money and labor expended in drainage than in any other improvement to land.

When I say drainage, I include irrigation, for in many places the application of moisture is oftentimes just as essential as the removal of the surplus water. And it is the province of the engineer to determine the cheapest and best methods of accomplishing the same.

It has been the object of your committee to secure as much information as we could on the subject, aiming, as far as possible, to add something new, and re-arrange many facts, which, though not strictly new, yet are important, and will at least do us no harm.

“A good story is none the worse for being twice told.”

The committee have not received any of the papers on drainage, hence they are not directly responsible for any of the good points or opinions expressed therein, but leave that for the Society to judge.

The following topics have been promised to the committee:

"Levees and Their Construction," by John O'Bannon, Civil Engineer, of South Bend, who has had charge of the construction of levees along the Mississippi river.

"The Repairs of Ditches, under the Repairing Act of 1889," by N. A. Beck, County Surveyor of Cass county, who has had a varied experience in that line, including test cases in courts.

"Tile Drainage," by M. A. Roder, ex-County Surveyor of White county, who is also an experienced hand on drainage, White county, we believe being the banner county for amount of ditching done.

"Earth-work: A New System of Tables," by John F. Meighan, Civil Engineer, South Bend, Ind., late Deputy U. S. Surveyor, New Mexico. The question of a table that will give accurately the amount of earth-work of all forms of the prismoid without additional process of multiples, subtrahends, etc., has been discovered by Mr. Meighan, who has spent many months of hard work in developing and perfecting the same, and is here made public for the first time.

"Kankakee Drainage," by Wm. Whitten, City Engineer of South Bend, and State Engineer of the Commission on removal of rock at Momence. Mr. Whitten was raised at the head of the Kankakee. His practical ability in engineering is second to none, and if he can't give us at least a partial solution of the Kankakee drainage problem, the rest of us had better not attempt it.

"Best Methods of Keeping Ditches in Repair," by J. M. McCormack, County Surveyor from Starke county. No county in the State needs ditches kept in repair any worse than Starke county, and perhaps no county presents more difficulties in that line. We hope to hear something practical.

Mr. Geo. A. Eagleston, County Surveyor of LaGrange county, will give us a paper on "Drainage."

Mr. James C. Thrawles, County Surveyor of Jasper county, has promised us a paper on "Drainage, Under the Act of 1891." He has charge of the largest system of drainage in the State under that act, and knows a little of the working of the law so far as they have proceeded yet.

"Joys and Sorrows of the Drainage Engineer," by John E. Alter, Civil Engineer of Rensselaer, Ind. His literary ability is well known in the northwest part of the State, and the Society can judge of it for itself. He is *one of the boys* that have *been there*, from the deepest swamps of the Kankakee and Iroquois to the highest sand ridges along the same.

Hoping that the next Committee on Drainage will do better, I am

Respectfully yours,

LEWIS S. ALTER,
Chairman.

THE REPAIR OF DITCHES UNDER ACT OF 1889.

BY N. A. BECK.

The law of 1889 is a law, good in its intent, but comes far from accomplishing its purpose. It would be well for farmers to repair their own ditches, if they would do it, but as a usual thing, they leave it until they have nothing else to do, and that time never comes. This unnecessary delay could be avoided (as it can under other laws), if the trustee attended to his duty, but the majority of trustees do not do it. At least, such has been the case in our county.

One of the most serious troubles we have met with, is the lack of time from the first day of August to the first day of November to do the work. On one ditch there was not two days to the allotment, and some had as much as three thousand (3,000) feet to repair, so it can be readily seen that the work could not be done. This defect could be over-

come if all, or some, parties would begin before the time specified by the trustee, and do a part of the work, but experience has proven that this will not be done. It seems from the reports of the various trustees that, rather than begin on time, the farmers want to wait just a little while after the time to begin, a request which is sometimes granted, especially if the trustee is an aspirant for some other office.

The trustee of one township informed me that he could have repaired all of his ditches throughout its entire length, had it not been for the provision in the law that no party can be compelled to do his work until each allotment between it and the outlet is finished. One man near the center of the ditch repaired his allotment, which gave parties above an outlet, but owing to the aforesaid provision some would not work and the parties below did not get up in time, so the ditch was not finished. Owing to circumstance like the one just mentioned, the trustee failing to give the proper notice, injunction suits, and misconstruction of the law, comparatively few ditches have been repaired in Cass county. I think out of about seventy-five ditches which were allotted in our county, up to the first day of August, not more than a half-dozen have been repaired, and some of those were not repaired, but gone over.

In places we find good work done and in places we find comparatively nothing done at all; nothing more than a narrow trench cut in the center of the ditch, sometimes not more than ten or twelve inches wide, which after a few freezes and thaws, will be little better than if there had been nothing done. One trustee in the county succeeded in getting his work all done, and well done, but he has (I think) only three or four ditches in his township, and they are all short, the longest not more than one hundred and fifty stations. This goes to show that where the trustee attends to his duty and the ditches are not too long, the law can be made a success; but this seems to be about the only place it can be successfully applied.

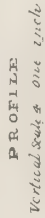
When I first began the work of allotting, I followed the plan of my predecessor, which I think with few exceptions is the only right way, and which no doubt I would have continued to do had I not run up against a circumstance in the shape of an injunction suit which brought about a decision of the Circuit Judge that revolutionized the allotting of ditches in Cass county and made all previous allotments illegal (so far as the Circuit Court goes). The judge decided that personal notice is necessary to make the allotments legal. He said the surveyor has the powers of a court, and that the way to get men before a court is to give them summonses. Since that time I have been doing so.

The first thing I do when I have a ditch to allot, is to examine the record, copy the specifications and assessments; after which I have the ditch staked off and levels taken. Then I make a profile and specifications, the specifications to compare as nearly as practicable with those of the original survey, but I change them if necessary to procure proper drainage for the lands. Next, I go with a map of the lands, carefully prepared, and examine each tract. I then go back to the office and make the allotments, and reduce them to writing, not in the drainage record, but on a blank prepared for that purpose, and place it in the drainage record. I then post up five notices of the day of hearing in each township, and serve one on each owner or occupant of land and one on the trustee of the township if the ditch drains a road.

On the day of hearing I'm always on hand, prepared for any emergency, and usually get a complete history of the ditch, from the time it was first seen by a white man, and sometimes get my own history related, and am sorry to say not always in the most complimentary way, either. Parties usually try to convince me that they have entirely too much to do, and that "John Smith," over there, drains all his farm into the ditch, and has comparatively nothing to do, while he drains only that *little bit of a patch*, and has almost *half* of the ditch to repair; or when you were out on the work, that you went home with some man for dinner, and he got off with

PLAN

Scale 588 one unit.



EMENT

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1/2

a light allotment. They say, "Oh! I tell you, some men are very smooth; they know just how to work you fellows from town." You hear such talk until you begin to think "life's a failure, or at least that of a surveyor is," and say to yourself, "Oh, everlasting day! will you never come to a close?"

After a lapse of ten days (if no remonstrance is made), I enter the allotments, as amended, in the drainage record. Then I make a transcript and specifications for the trustee, which completes my part of the work.

KANKAKEE DRAINAGE.

BY WM. M. WHITTEN, STATE ENGINEER OF KANKAKEE RIVER
IMPROVEMENT.

The Kankakee valley, or marsh, extending as it does nearly half way across the northern portion of this State, is estimated to contain about four hundred thousand acres, or nearly two per cent. of the entire area of the State. These lands were granted to the State on condition that the proceeds of their sale should be applied to their drainage; but, so far, the State has failed to fulfill the stipulation, or allowed the funds to be misappropriated, and although she may not be legally bound, she is certainly morally and equitably under obligation to comply with the conditions of the grant. Naturally the reclamation of so large a body of land, lying as it does in one of the best States of the Union, and so near the great metropolis of the Northwest, has been considered a matter of much importance, but when we consider the prodigious development which now seems to be the destiny of Chicago and its surroundings, this work becomes almost a *necessity*.

To my knowledge, the subject of the drainage of these lands has been discussed for at least forty years, and probably

longer; but up to this time, owing to real or imaginary difficulties in the way, very little has been accomplished. It is true that the owners of some of these lands, despairing of the State doing its duty in the matter, have expended large sums of money for ditches, in some cases with satisfactory results, but in most cases resulting only in disappointment and loss. The work heretofore done has been local in character and without any general plan. In exceptionally favorable localities the fact has been demonstrated that the marsh when drained makes valuable land, but in a great majority of instances the money expended in ditching has been practically lost, and in some cases the work done has been an actual damage either to the person paying for the work or to others. These facts emphasize the necessity of adopting a general plan for the improvement of the territory drained by the Kankakee river, and the importance of having all work done in harmony with such general plan.

Such a plan might, or might not, admit of the work being divided into two or more drainage districts, but provision should be made for preserving the unity of the work as a whole, and an equitable adjustment of benefits and damages.

When we consider that the cost of *thoroughly* reclaiming all these lands will probably amount to millions of dollars, and that the benefits of such reclamation will certainly amount to *many* millions, and further, that upon erroneous or inadequate methods, many thousands and perhaps millions of dollars may be expended uselessly, the great importance of the adoption of the best possible plan becomes apparent. The magnitude of the interests involved would justify the State in assuming control over the selection of such plan, and bearing at least a part of the expense of the execution of the work, even if she had complied in good faith with the requirements contained in the act granting these lands to the State; and as the matter now stands, she would not only be justified in doing so, but it would seem to be her *duty* to at least assist in this great undertaking.

Recognizing the necessity of unity of action and the mag-

nitude of this work (but not the duty of the State), in 1889 the General Assembly passed an act, which although general in its character, was primarily intended to apply to the drainage of this marsh. It was under the provisions of this act that the noted "Kankakee Draining Company" was incorporated. That company made surveys and estimates, located drainage channels, and made assessments on lands supposed to be affected thereby. I have not seen the plan adopted by this company, but understand it to be the one which by general consent seems to be considered the only one to adopt, namely, a straightening of the channel of the river, and I am informed that their channel in size and location was substantially the same as that adopted by Prof. Campbell in his survey and report in 1882.

Before the organization of this company, the opinion prevailed among land owners generally that the cost of straightening the river would not exceed a dollar or a dollar and a half per acre to the lands affected. When, therefore, the assessments were made as high as ten and fifteen dollars per acre, there immediately arose a universal protest. Charges of fraud were freely made and generally believed to be true. Excitement ran high in communities affected, and appeals to the courts were taken to test the validity of the assessments. In some counties the assessments were set aside by the courts, and in consequence the scheme fell to the ground, and soon after the act was repealed. Whether the charges of intended fraud were true or false, it is quite certain that the law was very loose in its provisions for the protection of the land owners, and the company *might* have acted dishonestly if it had seen fit so to do. Previous to the excitement caused by the operations of this company, it was almost universally conceded that the drainage of the marsh was desirable as a public benefit, and also as a greater benefit to owners of the lands; but during this excitement any point that could be urged against the justice of the assessments or against the advisability of the work was eagerly seized upon and used with all the force possible.

As an argument against the proposed work, it was contended that drainage would not benefit the marsh, in fact would be a damage to it; that if dry the marsh would burn up, and if the marsh did not burn up, the wild grass would be killed out; that it would not produce tame grass or any other valuable crops, but would all go to weeds. So persistently were these arguments used that many, probably a majority of the land owners, were made to believe them, and many have not yet changed their minds.

The prejudice engendered by the operations of this company against any attempt to drain the marsh prevented anything further being done for several years.

By an act of the General Assembly, approved April 11, 1881, the Governor was authorized to appoint a competent and skillful civil engineer, and making it the duty of such engineer, "under direction of the Governor, to make surveys and examinations with a view of acquiring exact information and ascertaining and selecting the best, cheapest and most practicable outlets for the drainage of the wet and swamp lands of the Kankakee region, and other large districts of wet lands in the State."

The very able and full report of Prof. John L. Campbell, of Wabash College, and Chief of United States Geodetic Survey for Indiana, who was appointed by Governor Porter as chief engineer under the provisions of said act, together with the map of the Kankakee region accompanying said report, are of very great value and afford data from which an intelligent idea may be obtained of the entire region. The following is the topography, in part, as given by Prof. Campbell in said report.

"GENERAL TOPOGRAPHY.

"The Kankakee region in Indiana lies chiefly in the counties of St. Joseph, Laporte, Starke, Jasper, Porter, Newton and Lake.

"The Kankakee river takes its rise in the elevated marsh land near South Bend, in Sec. 16, T. 37 N., R. 2 E.; thence it

runs through St. Joseph county to Sec. 14, T. 36 N., R. 1 E., from which point it forms the boundary line between La-Porte, Porter and Lake on the north, and St. Joseph, Starke, Jasper and Newton counties on the south.

"The river leaves the State in Sec. 1, T. 31 N., R. 10 W., and in the State of Illinois, by its junction with the Des Plaines, forms the Illinois river.

"The Kankakee river is noted for its extreme crookedness. Father Stephen, who made a careful survey of the channel, reports two thousand bends from the source at South Bend to Momence, Ill. By the same authority, the approximate length of the river between these points is two hundred and forty miles.

"The water in the stream is remarkably clear and is of excellent quality for domestic purposes. The iron, and possibly other mineral substances held in solution, give the water valuable tonic properties.

"The exceptional healthfulness of the Kankakee region, as compared with other large swamp districts, may be due, in a great measure, to these mineral qualities." (And, in this connection, I may say that Prof. Campbell contributed a paper to the last meeting of the Indiana Academy of Science, showing the feasibility of Chicago supplying herself with this pure water instead of pumping her own sewerage into her water mains.)

"The bed of the river generally is sand and fine gravel, and the banks are very low. The chief tributaries of the Kankakee on the north side are Grapevine, Little Kankakee, Vails, Mill and Hog creeks; on the south side, Potato and Pine creeks, Yellow river and Bogus creek. *Yellow river is the most important tributary and is scarcely inferior to the Kankakee above the junction of the two.

"West of Bogus creek on the south side, and of Crooked creek on the north side, the small streams from the uplands lose themselves in the marshes and have no well defined inlets to the river.

"The entire area of the country drained by the Kankakee

and its tributaries in Indiana is over sixteen hundred square miles, or approximately, one million of acres.

"The country adjacent to the river is a broad plain, varying in width from one to twenty miles, measured by sections north and south, with an average width of about ten miles.

"This plain has a declivity westward, of a little more than one foot to the mile."

(I would add to this description, that at the upper end, this plain has a fall from both sides toward the river, while at, and for a considerable distance above the State line, it has a declivity from the south side to the river, but on the north side of the river it is practically a dead level from the river to the north shore, and that the banks of the stream are usually higher than the adjacent marsh.)

"Along the irregular border of the plain, on both sides, are sand ridges, which give to the region the proper designation of the Kankakee valley.

"This valley is for the most part unreclaimed marsh, and except along the river banks and on occasional small sand islands, it is destitute of timber.

"Coarse prairie grass, wild rice, and weeds, grow in the greatest luxuriance in all parts of the marsh, and, in many places, even in the bed of the river itself.

"Frequently the highest water of the year is caused by the rank grass growth in the channel of the river during the summer season.

"The soil is a rich vegetable loam and sand, varying in depth from five feet to a few inches. Its general richness may be inferred from the rank growth of grasses, even in the lowest portion* of the marshes, where the water remains during the entire year.

"In St. Joseph county, and in some parts of LaPorte, Porter and Lake counties, the adjacent uplands have a plentiful admixture of clay, and the drainage from these uplands for ages has been adding fertility to the marshes, so that, not without reason, it is believed that these lands, when reclaimed, will be of the best quality.

"In Starke, Jasper and Newton counties, the uplands are more sandy, and consequently the marshes adjacent have less depth of soil; but there is no part of the valley which is not worth far more than will be the cost of reclamation.

"From its source to the mouth of mill creek, the river runs through the open marsh, but below this point the banks on one or both sides are covered with quite large trees.

"The total difference of level from station A, the small rivulet in Sec. 16, T. 37 N., R. 2 E., near South Bend, which is the source of the Kankakee, to the surface of the water below the dam at Momence, is one hundred and eight and one-tenth (108.1) feet. The total distance, as shown by the survey, is eighty-one and eighty-six hundredths (81.86) miles.

"The average slope of the marsh is approximately one and three-tenths (1.3) feet to the mile.

"There is no part of the line where a slope of one foot to the mile can not be obtained without any serious variation from a uniform depth for the new channel.

"I have made the estimates of capacity for the new channel on this lowest basis of one foot fall to the mile, although in nearly every part the fall will be considerably more.

"The mean level of the Kankakee valley is 674.5 feet above the ocean, from which it is important to notice that, notwithstanding its general marshy character, it is a broad valley which has a mean elevation of ninety (90) feet above Lake Michigan, and of one hundred and sixty (160) feet above the water in the Wabash river at Lafayette.

"Within the depth which will be required in the improvement of the Kankakee, no stone obstruction will be found from its source at South Bend to the limestone ledge near Momence, Ill. Throughout the State of Indiana the underlying strata are fine sand, increasing downward to coarse sand and gravel. Occasional thin layers of blue clay are found, but the excavations can be made generally in loose sandy soil and fine gravel.

"The soil proper consists of a dark sandy loam, varying in thickness, and sometimes found even to the depth of five or six feet.

"Profitable crops of wild hay are annually harvested from a large part of the marsh, and the partially recovered portions are found to be especially adapted to the culture of timothy, clover and blue grass. For stock farms this region will be surpassed by no section of the State."

Of the improvement Prof. Campbell says:

"The drainage and recovery of the Kankakee marshes will include: First, the construction of a better main channel than now exists, for the flow of the river; second, the straightening and deepening of the beds of the streams which empty into the main stream; and third, the digging of a large number of lateral ditches through the swamps to the improved channels.

"The portion of the work which seems properly to belong to State and national supervision, is the improvement of the main channel of the river. The other parts of the work may be left to the owners of the land, to be executed under our general drainage laws.

"Two streams, the Kankakee and Grapevine creek, unite near the northwest corner of Sec. 4, T. 36 N., R. 1 E., nine miles from South Bend, and form the Kankakee river.

"This junction seems to be the proper place for the beginning of the improvement under State supervision.

"The approximate length of the river in the State from this initial point is two hundred miles, as measured along the crooked channel, and the average fall per mile is less than four inches.

"The velocity of the stream is nearly uniform, and is about one and a half miles per hour, or one and two-tenths feet per second.

"The general declivity of the marsh through which the river flows, is 1.3 feet per mile.

"It is proposed to reduce the length of the river by the improvement, so that the distance from the initial point to Momence, Ill., will not exceed eighty-five miles, and the average fall per mile will be increased to more than twelve inches.

"The experiments of Messrs. Richards and Stephens, made in 1871, and reported by Mr. Bennet, civil engineer, show that the Kankakee river, one mile above Momence, Ill., has a sectional area of 1,026 square feet, a mean velocity of 1.424 feet per second, and the volume of discharge of 1,452 cubic feet per second.

"At the State line the sectional area is 543 square feet, the mean hydraulic depth is 4.5 feet, the calculated mean velocity is 2.35 feet per second, and the volume of discharge is 1,271 feet per second.

"In the determination of the dimensions of the new channels which will be required, I have assumed the correctness of the experiments made to determine the flow at the State line, and that the volume of discharge at ordinary stages of water will not exceed 1,271 cubic feet per second.

"To provide sufficient capacity for ordinary floods, I have given the lower end of the new channel, fifteen miles above the State line, an area of cross-section of 500 feet, and the calculated volume of discharge 1,358 cubic feet per second.

"It is proper to remark that so much depends on physical features peculiar in each particular case, that hydraulic formulas can serve only as general guides in the solution of any given problem. Absolute results can not be reached, and there is always room for honest differences of opinion among engineers as to the accuracy of conclusions."

The dimensions of the proposed channel at the source or junction of Grapevine creek with the Kankakee were as follows: Width of bottom, 27 feet; at top, 45 feet; depth, 6 feet; sectional area, 216 square feet; mean hydraulic depth, 4.26 feet; mean velocity, 2.105 feet; fall per mile, 1 foot. Discharge, 455 cubic feet per second. From these dimensions the channel increases to the following at the State line: Width at bottom, 42 feet; width at top, 69 feet; depth, 9 feet; mean hydraulic depth, 6.00 feet; mean velocity, 2.7 feet. Discharge, 1,358.6 cubic feet per second. The estimated cost of the entire work, at ten cents per yard for earth-work, was \$642,457.

The report recommends that the improvement be continued

from the State line to the rock ledge at Momence, and advises the removal of a portion of said rock for the purpose of giving a better outlet for the sand that will be brought down by the increased current in the channel above. The importance of the removal of the rock, as recommended in this report, has been greatly exaggerated, so much so that it is popularly regarded as the *key* to the drainage of the entire Kankakee valley.

Prof. Campbell evidently did not so regard it, but while considering its removal a great advantage, he could not have considered it as absolutely essential; for on page 24 of the report he says:

"The entire work may be divided into two general parts, the first including Divisions I, II, III and IV, from the initial point to Grand Junction, Sec. 36, T. 33 N., R. 6 W., and the second, including Divisions V, VI and VII, from Grand Junction to Momence.

"The distance from the initial point to Grand Junction will be 41.3 miles, and from Grand Junction to Momence, 43 miles.

"It is entirely feasible to begin the improvement of either of these general parts without delaying for the other, and pending the settlement of the proper question of the relation of the General Government to the lower portion as a navigable stream, it is recommended that work be begun as speedily as possible on the upper portion."

By reference to the maps accompanying the report, it will be seen that distances from Dunn's Bridge to Grand Junction, from Blue Grass Bridge to State line, and from State line to *Bull creek are nearly equal, and each about six miles on a straight line. From the elevations of surface of water at these points it will be seen that the fall in the first named distance is 3.2 ft., in the second 7.9 ft., and in the third 5.2 ft. Now if it is "*entirely feasible*" to begin an improvement at a point in the river that has only about 0.5 ft. fall per mile, as at

*The proper name for the creek noted on Prof. Campbell's map as Bull creek is Trim creek, Bull creek being further east, and not represented.

Grand Junction, it would seem to be at least equally feasible to commence at Bull creek (just above Rock Ledge), where the fall is 0.8 ft. per mile, and much more feasible to begin at State line, with a fall of 1.3 ft. per mile.

In fact, it would seem to be practicable to begin a straightening of the channel at almost any point in the river, but in such case, the marsh for some distance above the starting point would not be benefited, the distance required to secure sufficient depth to afford drainage depending upon the slope of the marsh. The proposition to extend the straightening of the river from the State line to Momence would therefore be the proper method to secure to *all* the lands in this State the benefits of such straightening. With the channel straightened to Momence, Prof. Campbell very properly recommends opening a way through the rock ledge in order to give a better outlet and prevent the deposit of sand in the channel at that point.

It was doubtless the intention of the Legislature when it ordered this survey, to do something by way of carrying out the improvement, but no action was taken upon Prof. Campbell's report, and for several years the matter seems to have been lost sight of by the State authorities.

In 1887 an effort was made to secure an appropriation from the State for the purpose of removing the rock ledge at Momence, but the dead-lock between the two houses of the Legislature put a stop to all legislation. In 1889, however, the effort was more successful and an appropriation of \$40,000 was secured. The act provided for the appointment by the Governor of three commissioners to have charge of the work. Governor Hovey appointed Prof. J. L. Campbell, Isaac D. Dunn and J. B. Kimball as such commission.

The Board was duly organized March 24, 1889, by the election of Prof. John L. Campbell as president, and Isaac D. Dunn as secretary. Wm. M. Whitten was appointed as Civil Engineer of the Board.

A careful survey of the river bed was made, from the commencement of the rock obstruction for a distance of a little

more than one and one-half miles down stream. A base line was run on the shore, along which station stakes were set 50 feet apart. At each station soundings were taken across the river at intervals of 25 feet, measured at right angles with the base. The difference between the mean elevation of the channel at the summit and at the termination of the survey was 5.9 feet. The same rate of fall, about four feet to the mile, continues to Miller's Island, about one and one half miles further down stream, making the total fall to that point about 12 feet in about three miles. It will doubtless be a surprise to many, whose ideas have been formed by reading newspaper descriptions of this great rock dam, to learn that the fall is so slight.

From the soundings taken, a working chart was prepared, from which was located a channel 100 feet wide and $7\frac{1}{2}$ feet deep, measured from the highest point of the rock. The grade line having a fall of 0.3 foot per mile below station 32 and a rise of 1 in 800 above said station. A flood channel 200 feet wide was also provided by removing all rock within five feet of the grade line of the main channel.

The amount of excavation required was 112,990 cubic yards. Total length of the improvement 8,649 feet.

The grade of the channel may be criticised, but I desire to say that, as is too often the case in planning improvements of a public character, the engineer was hampered by certain conditions found in the conveyances of right of way, also in the act of the Legislature, and these conditions were more potent in the determination of many questions than were the requirements of good engineering. The deeds required the channel to be not less than 100 feet wide and 7 feet deep. The act of the Legislature required the channel to be 200 feet wide on top and not less than 25 feet on the bottom and $7\frac{1}{2}$ feet deep at the highest point of elevation of the rock. On account of the small appropriation, the commissioner desired to keep the amount of excavation at the lowest possible limit that would fulfill all the conditions. The "highest point of the rock" was therefore selected, and I may remark that it was *only a*

point, and from this point the depth of the proposed channel was estimated.

This point was at station 32 of the survey, near the right bank, and was about 1.4 feet above the mean elevation of the natural bed of the river. At this station, therefore, the proposed channel, the bottom of which was 7.5 feet below "the highest point of elevation," was only about 6 feet below the natural bed of the stream. The sectional area of main and flood channels was 649 square feet. This point being the only one at which the depth is fixed by the act, the grade was raised to meet the surface at station 0. At station 95 of the survey, the main channel passes through what is generally known as the upper dam; this is an artificial dam extending from the left bank of the river to the head of an island, the upper portion of which is now owned by the C. & E. I. R'y Co., and used by said company as picnic grounds. The crest of the dam is about 5 feet above the natural channel at that point, and about 3 feet higher than the mean elevation of the natural bed of the stream at the summit of the rock ledge. The length of the island is about 3,300 feet, and it divides the river into two nearly equal channels, known respectively as the North and South Channel. About 2,000 feet down stream from the head of the island, another artificial dam, known as the lower dam, the crest of which is 0.7 foot below crest of upper dam, is thrown from the island across the North Channel. These artificial dams set the water back over the crest of the rock ledge and for a considerable distance above it, thus affording very good boating facilities. The railway crosses the island about midway between the dams, and crosses the South Channel, through which the proposed improvement runs, at about station 125 of the survey.

The railway company, at a considerable expense, has fitted up the island for a pleasure resort, to which frequent excursion trains are run from all points on the road. The removal of one, or both, of these artificial dams would impair the boating facilities of this resort, and the company estimates the loss from this source at from twenty to thirty thousand dollars per annum. The title of the railroad to the island was obtained

through Gen. Cass, who, owning large tracts of the Kankakee marsh lands, had purchased the island, with the water power for which these dams were originally constructed, for the express purpose of controlling or removing the dams to facilitate the drainage of said lands. In the deed to the railway company Gen. Cass reserved all rights in the water power, but in a letter to the company, written during the negotiations leading to the sale of the island, Gen. Cass made statements which the company now claims gives it the right to insist on the preservation of the dams. This claim the heirs of Gen. Cass deny, and insist that they have a right to remove the dams, and in May, 1890, proceeded to do so. The company obtained a temporary injunction; the case was tried in the Kankakee Circuit Court, resulting in favor of the Cass estate. From this decision the railway took an appeal to the *Appellate* Court, where the case is still pending. Although the railway company has no deed for the right of way over the South Channel, they claim the right by prescription, and refuse their consent to the improvement being made across the same. They also claim riparian rights in the channel as owners of the island, and also as owners of the left bank of South Channel from about station 110 of survey to their track.

If the railway company can make good all its claims, any work that may be done by way of removing the rock ledge, will be a useless expenditure of money, for, as above stated, the crest of the upper dam is 3 feet and of the lower dam 2.3 feet higher than the crest of rock ledge.

Notwithstanding the complications arising from these claims of the Railway Company, the Board of Commissioners, upon the urgent request of interested parties, decided in July, 1890, to advertise for bids for doing the work, to be received Sept. 1, 1890. There were three bids in response to said advertisement, one at 90 cents per yard, or \$101,691 for entire work; another at 87 cents per yard, or \$88,132.20 for entire work; the lowest being by Emil Sirois for \$34,800 for the entire work. It was generally understood that the lowest bidder, Mr. Sirois, the only one whose bid came within the appropri-

ation, was really the agent of interested parties, who, rather than see the work fail, expected to bear any loss that might be incurred in doing the work at the price bid. The lowest bid was accepted by the Board, and Mr. Sirois given time in which to file the required bond. For various reasons, this time was extended from time to time, and has not yet been completed.

In their annual report to the Governor for the year 1890, the Commissioners asked the Legislature to amend the act so as to authorize the Board to make such changes in the length width and depth of the channel as may be found expedient, provided the sectional area shall not be diminished. They also ask for an appropriation of \$5,000 to cover the expense of the commission and superintendence of the work. The Legislature granted the amendment asked for with reference to the channel, but refused the appropriation, and also required an additional bond of the members of the commission. May 15, 1891, after the passage of the amendment, Prof. J. L. Campbell, President of the Board, and Isaac D. Dunn, Secretary, both resigned as Commissioners, thus leaving but one member, Commissioner J. B. Kimball, of the Board in office.

These vacancies remained unfilled until October last, when Hon. Franklin Landers and John Brown, of Crown Point, were appointed as Commissioners. November 11, 1891, the Board re-organized by electing Hon. Franklin Landers, President, and J. B. Kimball, Secretary.

The lowest bidder having failed to give the bond required, the new Board, hoping for an early decision in the pending litigation, have readvertised for bids to do the work, to be received February 2, next.

If the work proceeds there will probably be some change in the plan.

Regarding the effects of this work if carried out, greatly exaggerated ideas are generally entertained. It is supposed that the surface of the water in the river, at the summit, will be lowered seven and one-half feet, and that the effect will be felt a great distance up stream.

Now let us suppose the artificial dams are removed and the work as originally planned carried out. The sectional area of main channel at station 32, measured from the bed of the natural channel at the left bank of flood channel which is, 6.1 feet above datum, is 560 square feet, the grade of channel is 0.3 foot per mile, but allowing for increased slope of the surface of water, caused by the spreading of the water over the wider natural channel at the lower end, it would probably be safe to estimate the fall at one foot per mile; the mean hydraulic depth, 5.05 feet; velocity 2.35 feet per second; discharge, 1,316 cubic feet per second. The area of the flood channel at the same station is 60 square feet mean hydraulic depth .6 foot, velocity .44 foot per second. Discharge 26.4 cubic feet per second, making the total discharge when running full or to a level with the natural bed of the river 1,340.4 cubic feet per second. This is 109 cubic feet less than the engineers of the Kankakee Draining Company found at this point in 1871, the year of the great Chicago fire, which will be remembered as an extremely dry season. It is therefore safe to assume that only in extreme low water would all the water be contained in the improved channel, and the surface of the water be as low as the present bed of the channel. To discharge an equal amount by the natural channel, with the artificial dams removed, the surface would be 8.25 feet above datum; the sectional area, 565 feet; hydraulic mean depth, 1.83 feet; fall 4 feet per mile. Velocity 2.05 feet per second; discharge 1,340.7 feet, from which it appears that in very low water the surface will be reduced from 8.25 to 6.1 feet above datum, a difference of only 2.15 feet. The surface of water at high stages will be affected even less than in low water, as will appear from the following: The sectional area of natural channel at ordinary high water at station 32 is 2,819 square feet; wet perimeter, 432 feet; hydraulic mean depth, 6.52 feet. If the dams are removed the fall would be 4 feet per mile, mean velocity 5.66 feet per second, discharge 15,955 cubic feet per second, surface of water 13.74 feet above datum.

After completion of the improvement as proposed, with the water 12.4 feet above datum, the fall per mile would be reduced to 3 feet per mile, the sectional area would be 2,903 feet, mean velocity of the entire section 5.49 feet per second. Total discharge 15,937 cubic feet per second. This discharge is slightly less than that of the natural channel at high water, while the surface has been reduced from 13.74 feet to 12.4 feet above datum, amounting to only 1.34 feet. It would therefore appear that the effect of the removal of the rock as proposed, would be to lower the surface in dry weather, when it is least needed, about 2.15 feet, and in high water, when it is more necessary, only about 1.34 feet, while in time of flood the effect would be still less perceptible. So slight a reduction of the surface at this point, it is needless to say, would affect the surface of the water at the State line but little, and above the State line the effect would soon practically disappear.

To give an approximate idea of the results such a reduction would produce, I may say that I am informed, that when the flush boards were removed from the dam recently, the water just above the dam fell one foot, and just above the State line it fell two inches. This fall at the State line is greater than I would expect, but assuming its correctness, the effect of removing the rock as proposed would reduce the water in the river at the State line only about four inches; this, in time, might be somewhat increased, but probably never so much as one foot. Now, as to the effect it would have upon a straight ditch from the State line, beginning say at the I. I. & I. R. R. and running to the mouth of Bull (Trim) creek. The elevation of marsh as shown on the map at the State line is 628.6 feet; the surface of water at Bull creek, 619.1 feet, a fall of 9.5 feet. If the rock were removed, the fall would be increased to 11.5 feet. The distance is about six miles, and with a fall of one foot per mile, the surface of water in the ditch at State line would be $5\frac{1}{2}$ feet below surface of marsh. This gives a good fall and good depth of drainage. By reducing the fall to 8 inches per mile, and increasing the sec-

tional area of the ditch about 20 per cent., the same depth of drainage, and the same discharge, could be obtained *without removing the rock*.

It would therefore appear that this rock ledge is by no means the *insurmountable* obstacle to the drainage of the Kankakee region in Indiana which it is popularly supposed to be.

It may be admitted that the removal of the rock, and also the removal of the artificial dams, are of very great importance to the marsh lands lying immediately above the obstruction ; but as the distance from the lands to the obstruction increases its importance diminishes, so that the principal benefits occasioned by the removal would be the lands lying west of the State line. Notwithstanding this fact, however, the benefits to Indiana lands would fully justify the expenditure of the amount proposed in the removal of the rock if the artificial dams can also be taken out. But if this *can not* be done there is no reason for discouragement at the prospect for accomplishing the *complete reclamation* of the *Indiana lands*. This fact has been practically demonstrated by Mr. J. L. Clark, civil engineer, who by a very ingenious combination of dykes and drains, has reclaimed about a thousand acres of the marsh lying just east of the State line and north of the river. This tract was selected by General Cass as the most difficult tract in the State to drain. Yet Mr. Clark has accomplished the task, and has done so not only with the rock ledge untouched but with the artificial dams rising several feet above the ledge. Moreover, he did not utilize all the fall that might have been obtained, by extending his outlets to Bull (Trim) creek. This would have increased the efficiency of the work, but could not be accomplished on account of the opposition of some of the land owners. Mr. Clark has prepared a description and plat of this work for the Illinois Society, and has kindly furnished a copy of same for our information, which I would recommend be published with the proceedings of this Society.

MODES OF RECLAMATION.

Since my connection with the proposed removal of this rock ledge, which is designed to be preliminary to the drainage of the Kankakee marsh lands, in considering plans and estimates it has been necessary to give some attention to the method that may be adopted for the reclamation of these lands. In considering the subject, the conviction has been gradually forced upon my mind that the plan which is very generally conceded to be the most feasible, and by many thought to be the only one possible, is not the best method to adopt, and that if this method be adopted, the dimensions proposed are entirely inadequate to accomplish the desired result; whether this view be correct or erroneous, the magnitude of the interests involved certainly justifies a very careful investigation of the subject. In this connection Prof. Campbell very truthfully remarks "so much depends on physical features" peculiar to each particular case, that "hydraulic formulas can serve only as general guides in the solution of any given problem." "Absolute results can not be reached, and there is always room for honest difference of opinion among engineers as to the accuracy of results."

The fact that engineers may, and frequently do, differ honestly as to conclusions in problems of this kind, makes it all the more important that enterprises of this magnitude be thoroughly investigated, and if differences of opinion are found to exist, all important facts are the more likely to be brought out, and therefore the probabilities are increased of a correct conclusion being reached.

The plan, above referred to, briefly stated, is a straightening and deepening of the river for a main outlet to the lateral streams and ditches which are to drain the marsh. It was adopted by the celebrated Kankakee Draining Company, and described by Prof. Campbell in his report above referred to. That report will continue to be referred to as well as the map accompanying the same, and it is respectfully suggested that a copy of the map be printed in the report of this Society.

Assuming that the object sought is to so thoroughly reclaim these lands that they may be cultivated and made to yield, with a reasonable degree of certainty, the large and profitable crops which the rich soil is capable of producing (as anything less than this would only destroy the wild grass which is now valuable for hay, to give place to worthless weeds), what are the necessary requirements?

First. The water must be removed from the surface. The importance of this is recognized by all. The proposed improved channel, at the State line, is estimated to have a capacity of 1,358 cubic feet per second, which is 87 cubic feet in excess of the assumed ordinary flow, 1,271 cubic feet. With the width and fall of this channel, this difference in flow would affect the surface only about six inches; that is to say, in *ordinary* stages the water would fill the channel to within six inches of the banks. This would scarcely be sufficient to remove all the water from the surface, as there are many depressions from 6 to 12 inches below the general level of the marsh. Moreover, the *ordinary* flow would have to be increased only seven or eight per cent. to overflow the banks and spread over the marsh. That this is a very insignificant increase is evident from the fact that the difference between the ordinary flow and ordinary high-water discharge at the summit of the rock is *seven or eight hundred* per cent. That this allowance against overflow is exceedingly small is further evident when we consider that, according to Kutter's formula, the difference in velocity, due to the fact that the channel may contain some stone and weeds, instead of being entirely free from these obstructions, is 14 per cent., and therefore this slight difference in the character of the sides and bottom of the channel would cause it to overflow its banks and flood the marsh.

This plan would therefore leave the marsh dependent, for an outlet, upon a channel running nearly or quite to full banks at ordinary stages, thus leaving the soil fully saturated at all times, and *flooded* at every slight raise in the outlet.

Second. All authorities on drainage agree that it is not only necessary to remove all surface water, but that the water table, or line of saturation, must be so reduced as to leave sufficient depth of drained soil to answer the purpose of agriculture. Concerning this depth, Col. Waring, in "Draining for Profit," says: "The depth to which the water table should be withdrawn depends not at all on the character of the soil, but on the requirements of the crops which are to be grown on it, and these requirements are the same in all soils—consequently the depth should be the same in all. What, then, should that depth be? The usual practice of the most experienced drainers seems to have fixed four feet as about the proper depth." John Klippart, in his work on "Land Drainage," says: "There has been an immense amount of controversy between the advocates of shallow drains and the advocates of the deep, the one preferring a depth of two and one-half feet, the other a depth of four feet. Practical and experienced men have come to regard these two opinions as indicating the possible range of useful drainage, either of which may be adopted under special circumstances, while in almost all cases the most useful and economical depth lies between these extremes, or about three feet. We would not advise any one to underdrain at a less depth than 30 inches, and where the full and pecuniary means will warrant, we would *insist* that three feet should be considered the *minimum*, in all soils requiring underdraining." Mr. French, in his work on "Farm Drainage," says: "We can not, however, against the overwhelming weight of authority, and against the reasons for deeper drainage, which to us seem so satisfactory, conclude that even three feet is in general deep enough for under-drains. Three foot drains will produce striking results on almost any wet soil, but four foot drains will be more secure and durable, will give wider feeding grounds to the roots, better filter the percolating water, warm and dry the land earlier in spring, furnish larger reservoirs for heavy rains, and, indeed, more effectually perform every office of drains." * * * "Finally, in view of the various consider-

ations that have been suggested, as well as the almost uniform authority of the ablest writers and practical men, it is safe to conclude, that, in general, in this country, wherever sufficient outfall can be had, four feet above the top of the tile should be the minimum depth of drains."

Thirty inches is the least depth of drainage that any of these authorities consider admissible. To secure this depth in the depressions lying back from the channel, and provide a reasonable fall for lateral drains, the surface of water in the outlet should be at least $5\frac{1}{2}$ feet below the general level of the marsh, and consequently the capacity of the outlet should be estimated with the surface of the water $5\frac{1}{2}$ feet below the banks, instead of at, or near, full bank, as these channels were calculated.

The above considerations clearly indicate, to my mind, the inadequacy of these channels, even in *dry* weather; what, then, can be said of their efficiency during rainy seasons?

The same conclusion may be reached by comparison with the present channel of the river. Mr. J. L. Clark, civil engineer, estimates the average sectional area of the natural channel at about 1,500 square feet for the first ten or fifteen miles above the State line. I made a rough cross-section at the N. A. & C. R. R. bridge, and found it about 1,400 square feet. The United States field notes show the distance across range 9 west, as measured by the meander of the south bank of the river, which seems to have followed the channel quite closely, to be 877.17 chains, or not quite eleven miles, or 1.83 times the distance measured on a straight line. If we assume the length of the old channel to be double the length of the new, with an equal hydraulic mean depth in both channels, the velocity in the new channel would be 1.41 times that in the old, and the sectional area in the new must be equal to 70 per cent. of the old, in order that the discharge may be the same. This would indicate that the straight channel, to be equal to the full capacity of the natural channel of the river, should have a sectional area of 980 square feet, or nearly double that proposed for the improved channel. In other words,

the improved channel will be only about half as efficient as the river in its present condition. This conclusion is further supported as follows: By reference, the elevation as shown on the map, the marsh on State line at I , I. & I. R. R. is 628.6 feet, the elevation of surface water at State line is 624.3 feet, a difference of 4.3 feet. Now, since the surface in the improved channel was but 0.5 foot below the marsh, while the water in the river is 4.3 feet below the marsh, it is evident that the old channel gives 3.8 feet deeper drainage than the new. Now, to raise the water in the river 3.8 feet, so as to bring it up to a level with the water in the proposed new channel, would increase the hydraulic mean depth to over 8 feet, which, it is safe to say, would fully double the discharge.

The inadequacy of the natural channel to effect the drainage of the marsh being so fully demonstrated, what could be expected of a channel of only about one-half its capacity?

It may be suggested that after the proposed straightening, the united capacity of both channels would be available. Such, however would not be the case, even if both channels could be kept open, for on that portion which follows the old river bed, there would be but one channel, and these sections would measure the capacity of the improved outlet. But the action of the river shows that it would be practically impossible to maintain both channels, for as soon as the river changes its channel by cutting off one of its many bends, it immediately proceeds to completely fill the upper end of the old channel to the height of adjacent banks, while the lower end is converted into one of the numerous bayous that abound along this river. Nor is the action of the river in this respect confined to filling its own old channels, for in several instances it has been known to fill ditches that have been cut across bends with a view of straightening the river. As a notable instance of this action may be mentioned the fact that Mr. Singleton attempted to straighten the river across the great bend just west of the State line, by cutting a large ditch on the *line recommended* for this improvement. Instead, however, of the river following this ditch and washing it wider

and deeper as it was expected to do, the next high water filled up the upper portion of the ditch, and the river continued in the old channel. On the other hand, numerous instances are reported, where very insignificant trenches cut across bends have turned the course of the stream.

These facts render the effect of the proposed improvement extremely problematical. If the river should choose to follow the natural channel and fill up the new, nothing would be gained; if it should conclude to abandon the old channel and follow the new, in whole or in part, the efficiency would be *reduced* to the capacity of the new, at the least until, by its own action, it should increase the size of the new channel to equal the capacity of the old. This, at best, would require *much time*, and we have no assurance that it would ever be accomplished. In this connection a remark made by Prof. Campbell before the State Board of Agriculture, is pertinent. He says: "The length and direction of a river are determined by natural laws and shortening will violate these laws only to create disturbance where now are repose and stability" * * * "and in the end will result only in defeat."

It is contended, that after the reclamation of these lands, there will be less water to be drained into the outlet, and therefore smaller channels will answer the purpose. The argument is stated as follows: "After the drainage has once been accomplished and the lands brought under cultivation, there will be a great diminution of the volume of water to be carried off. The absorbent power of the reclaimed land and evaporating surface will be increased, and the quantity of surplus water will be proportionately diminished." This statement would seem to imply that drainage effects some permanent chemical or mechanical change in the soil which increases its power of evaporation and absorption. It is probable, however, that this was not the meaning intended, for as a matter of fact, the drainage has been accomplished, not only *once*, but probably hundreds of times heretofore, and will continue to be accomplished every time a sufficiently pro-

tracted drought occurs. During the past season the water table, or line of saturation, was reduced several feet below the surface of the marsh, and *whenever* and *wherever* this occurs, the drainage of the soil is *accomplished*. As proof of this assertion, the fact may be stated that, in some exceptional seasons, large crops of corn have been produced on these marshes, which in all ordinary seasons are entirely worthless; some of these crops could only be gathered in boats. If, therefore, any such change in the nature of the soil were produced by drainage, that change has already been effected. The truth is that the soil is generally a sandy loam, through which water drains quite readily; that owing to its comparatively low situation, it is usually either covered or fully saturated with water; that whenever the water table is sufficiently lowered either by evaporation, by slow percolation into the streams, or by thorough drainage, the land is in condition to produce crops, but as soon as from any cause the soil becomes again saturated, it again becomes unproductive.

Now, assuming that the amount of water that would be required to raise the water table, or line of saturation, to the surface, would be the measure of the absorption of the soil, then the statement that drainage increases the absorbent power of the land would be unquestioned, and the deeper the drainage, the greater the absorption; but that this increase of the absorbent power of the soil diminishes the volume of water to be carried off, does not necessarily follow. If water after being absorbed by the soil is not evaporated, it must either remain to saturate the soil, thus rendering the soil unproductive, or be drained by artificial or natural drains into the outlet streams. A drained soil may *absorb* all the the water of a very heavy rain storm, but it can not *annihilate* a single drop. After being absorbed by the soil the water will remain to saturate the soil until removed by evaporation, or drained into the outlet stream. There are doubtless instances in which the under-drainage of strong clay soils has changed the mechanical conditions of the soil and rendered it more porous, allowing water to penetrate

more freely, and perhaps contain a greater amount in a given depth of soil, on account of which change the soil acts as a reservoir, to hold back the water which formerly, on account of the impervious nature of the soil, ran over the surface into the ditches and streams. In such a case, if the surface has considerable slope, the effect of drainage might be to diminish the amount of flow in the streams after heavy rains, but it would probably be found to last longer and so give the same aggregate amount. But the soil of this marsh is a very different nature, being sandy and naturally very absorbent, and having frequently had the water drained out of it to a considerable depth, no further change can be expected to follow in this respect when the marsh is reclaimed. It therefore appears that the absorption of the soil will *not* decrease the amount of water drained into the outlet by these lands. What then will be the effect of drainage upon the amount of *evaporation*? According to the above quotation it will be increased, and in consequence the drainage water diminished. In regard to this point I may say that I know of no writer on the subject of drainage who does not cite, as one of the greatest benefits conferred by thorough drainage, the fact that such drainage, by *decreasing* evaporation, prevents the loss of heat occasioned thereby, and therefore renders the soil warmer. Col. Waring gives an instance in which the excess of evaporation of an undrained, as compared with drained soil, reduced the temperature of the wet soil $6\frac{1}{2}$ degrees F., while French says, "drainage often raises the temperature of the soil as much as 15 degrees F.," and all seem to agree that evaporation is greater from undrained than from drained land. On this subject Henry F. French, in his valuable work on drainage, at page 293, says: "In another chapter we have considered the subject of 'Evaporation and Filtration,' and endeavored to give some general idea of the proportion of rain which escapes by evaporation. We have seen that evaporation proceeds much more rapidly from a surface of water, than from a land surface unless it be *fully saturated*, and that evaporation from water exceeds the whole amount of rain

about as much as evaporation from land falls short of the amount of rain—as evaporation is greater, other things being equal, according to the *wetness* of the surface.” * * * “If the field be covered with water it becomes a water surface for the time. If, as is often the case, the water stands on it in spots on half its surface and the rest is saturated, the evaporation is scarcely less, and has been said to be even more; while if the surface be comparatively *dry*, the evaporation is *very little*.”

John H. Klippart, in his able work on “The Principles and Practice of Land Drainage,” at page 73, in speaking of some experiments to determine the rate of evaporation, says: “The average amount of rain at the places of observation was about 25 inches per year; the evaporation from *water* exposed to both sun and wind, was about 35 inches per year; shaded from the sun, but exposed to the wind, it was about 23 inches; from *soil*, when drained, about 20 inches; and from undrained soil, about 33 inches, an *excess* of 13 inches to be charged against an *undrained* soil.” On page 82, the same author, in commenting on a table giving results of a long series of observations, says: “In the first place, it is observable how much greater is the amount of evaporation from water than from *land*, and how near, as shown by columns 2 and 5, the evaporation from *wet* land is to that from water itself, hence the wetter the land the greater the evaporation.” On page 89 of Fanning’s “Water Supply,” tables No. 24 and 25 show the percentage of evaporation to rainfall as follows: From water, 127 per cent.; from short grass, 137 per cent.; from long grass, 200 per cent.; from earth, 56 to 67 per cent. Other authorities might be cited, but rather than tax your patience further, I will let these suffice. They clearly show that evaporation is much more active on wet and overflowed land than on drained soil, and that vegetation increases evaporation very largely. It would therefore seem that these marshes, wet and overflowed as they are, and yielding immense crops of grass and weeds, which probably exceed, in the aggregate, the greatest amount of vegetation that cultivation would produce, are

in more favorable condition to evaporate large quantities of water in their natural state than they would be if drained. Assuming then that the amount of rainfall will not be affected, that absorption does not annihilate any water, that the aggregate growth of vegetation would not be increased, and that evaporation would be diminished by drainage, the conclusion is irresistible, that the volume of water to be removed would be increased by the reclamation of these lands.

From this conclusion it does not necessarily follow that the amount that will flow to the outlet channel will be increased to a uniform extent throughout the season; for, by means of the artificial channels provided, the most of the surplus water will find its way more rapidly into the main outlet, causing it to rise rapidly to a greater height than before, and thus discharge the increased volume quickly, leaving a diminished amount to supply the flow during a dry season. On this point Mr. French in his chapter on, "Effects of Drainage on Streams," says:

"If now, this surplus of water, this part which can not be evaporated, and must therefore, sooner or later, enter the stream or pond, be, by artificial channels, carried directly to its destination, without the delay of filtration through swamps and clay banks, the effect of rain to raise the streams and ponds must be more sudden and immediate. Agricultural drains furnish these channels. The flat and mossy swamps, which before retained the water until midsummer drought, and then slowly parted with it by evaporation or gradual filtration, now, by thorough drainage, in two or three days at most, sends *all* the surplus onward to the streams. The stagnant clay beds which formerly, by slow degrees, allowed the water to filter through them to the wayside ditch and then to the river, now, by drainage, contribute their proportion, in a few hours, to swell the streams. Thus the *evaporation* is *lessened* and the amount of water which enters the natural channels largely increased; and what is of more importance, the water which flows from the land is sent *at once* into the streams. This produces upon mill streams a two-fold effect,

first, to raise sudden freshets, to overflow the dams and sweep away the mills, and, secondly, to dry up their supply in dry seasons. *Upon the low meadows which border the streams* the effects of the drainage of lands above them are various. In many cases it must subject them to sudden *inundation* by *summer freshets* and must require for their protection, catchwaters and embankments and *large facilities* for drainage."

That these are not mere speculations of our own, may be seen from extracts which will be given from answers returned by distinguished observers of these matters in England and Scotland, to a question proposed to them as to the *actual effects* produced by extensive drainage:

Mr. Parks.—"The intention and *effect* of a complete and systematic under-drainage is the liberation of the rain more quickly from the land than if it were not drained; and therefore the natural vents, or *rivers*, very generally require *enlargement* or *deepening* in order to pass off the drainage water in sufficiently quick time and so avoid *flooding lower lands*."

Mr. Spooner—"The effect which extensive drainage produces on the *main water courses* of districts, is that of *increasing* the height of their rise at flood times, and rendering the flow and subsidence more rapid than before."

Other authorities might be cited, but these, together with the following extract, taken from a paper read before the State Board of Agriculture by Prof. J. L. Campbell, Chief of the United States Geodetic Survey for Indiana, would seem to be sufficient. In speaking of the drainage of the class of marshes bordering the larger streams of the State, Prof. Campbell says:

"The tile drainage of the farms, the hundreds of miles of open, straight ditches, the removal of the heavy undergrowth and the clearing out of the channels of the creeks have destroyed the storage reservoirs which kept up the water supply for our rivers and have reduced their average size to less than half what they were sixty years ago." * * * "These surface improvements, however, have so increased the velocity of all the tributaries, from drain tile to the creek, that the car-

rying capacity of the river is *over-taxed* and the danger from floods is *greatly increased*." * * * "These floods, of late years, have diminished the value of bottom lands along the Ohio, Wabash and White rivers, and many tracts, once farmed, are now thrown out as worthless." It is true that Prof. Campbell had reference to rivers classed with the Ohio, Wabash and White, but by substituting in the first sentence of the above quotation, instead of the third clause, which reads—"The removal of the heavy undergrowth"—a clause reading "the removal of the heavy growth of cat-tail and saw-grass," the quotation would be equally applicable to the Kankakee river after the reclamation of the marshes. All of these authorities agree that drainage increases the height and frequency of freshets or floods.

The general character of the Kankakee water-shed could hardly be more favorable to a uniform flow in the river than it has been left by nature. Forty per cent. of its area, containing four hundred thousand acres of open marsh, exposed to the full effect of sun and wind, with a saturated surface, or covered with water, and consequently in the most favorable condition possible to produce evaporation, and covered with a growth of vegetation to further increase evaporation; with the bank of Crooked river generally higher than the marshes adjacent, thus converting the marshes into huge shallow reservoirs for impounding the drainage water from the higher portions of the water-shed, as well as the rainfall on its own surface, and holding this water until it is either evaporated by sun and wind, or slowly percolated through the soil into the river, are conditions well calculated to produce a very uniform flow into the river into which it drains. This conclusion is supported by comparing the flow with the flow of other water-courses having the same area of water-shed. Mr. J. L. Clark, Civil Engineer, reports the sectional area of flood at Momence to be 4,748 square feet, which would give a discharge of 36,084 cubic feet per section. The Kankakee Drainage Company reports mean flow at State line to be 1,271 cubic feet per second; according to an analysis of the published

record of flow in streams, as given in tabular form on page 75 of T. J. Fanning's "Water Supply," the mean summer flow and the flood flow per second, per square mile, of a water-shed of 1,600 square miles, should be .8 and 59 cubic feet, respectively, giving a total flow of 1,280 cubic for mean, and 94,400 cubic feet for flood flow. This mean flow, as will be seen, agrees very closely with the measured flow at the State line, while the volume of flood discharged is nearly three times as great as the measured discharge at Momence. This shows that the fluctuations in this stream, between mean and maximum flow, are only about one-third of the fluctuations in ordinary streams. Both theory and observed facts, then, agree that the present volume of flow in this river is unusually constant. Now it is evident that any cause which will produce a change in this constancy of flow, will increase the height or frequency of floods, as well as diminish the flow at low water; *drainage* effects such change, as is heretofore shown, and consequently increases danger from high water and floods.

The sectional area at the summit of the rock of ordinary high water, that is to say, the stage of water which may reasonably be expected to occur, one or more times, during each summer season, is about 2,819 feet. With the artificial dams in the channel below, the discharge at such time would be over 11,000 cubic feet per second, which is more than seven times the estimated flow at the ordinary stages of water, upon which the estimate of capacity of the proposed channel is based. If, therefore, the capacity of the proposed channel were increased *seven-fold* during this stage of water, the channel would run *full* and give no outlet for lateral drains, and to afford relief to these drains at such stages of water, when it is most needed, would require that the capacity of main channel be increased at least ten-fold. Even such a channel would only discharge forty per cent. of the flood water, and therefore the entire marsh would be overflowed at each freshet. These figures are based on estimates of flow under present conditions, and would have to be increased for any increase of volume due to drainage.

In the foregoing I have attempted to show that a plan for an improved channel, the capacity of which is estimated when running nearly, or quite full, to be equal only to the present ordinary flow of the river, would be less effective than the natural river bed as a main outlet; that in ordinary stages it would not afford outlets for lateral drains; and that a very slight increase in amount of flow or roughness of channel would flood the marsh; that to give outlets for lateral drains the surface of water in main channel should be at least $5\frac{1}{2}$ feet below the surface of the marsh; and that this depth is more essential in wet seasons than in dry; that the effect of the action of the large volume of water that must pass through the lower portion of this channel, upon the unstable sand through which the channel passes, can not be predicted with any degree of certainty, and that the straightening of the river, by means of a channel of the proposed dimension, might diminish the flow, and, at best, could not be depended upon to increase the discharge beyond the present natural capacity, that the increased absorbent power of the lands after drainage will not *decrease* the *aggregate* amount of drainage water; that instead of drainage increasing evaporation, it will diminish it, and thus increase the volume of water to be carried off through the main outlet; that the natural flow of the river is much more constant than ordinary streams having like water-sheds, and that any cause which tends to diminish this constancy of flow, without at the same time diminishing the quantity of drainage water, increases the danger from floods; that drainage will decrease the uniformity of this flow without decreasing the total volume to be removed, and, therefore, will increase the danger of floods, thus rendering large outlets the more necessary; that the volume of water passing the summit of rock during each growing season is seven times as great as the volume at the stage upon which the estimates of capacity of the improved channels were based; that to provide at this stage of water an outlet for lateral drains would require the capacity of the proposed channel to be increased ten-fold, and that even such a

channel would carry only about forty per cent. of the flood volume, and consequently the lands would be overflowed during each freshet.

It may be contended that the expense of providing sufficient outlets for floods will not be justified by the benefits derived; that it would be better to leave these lands subject to overflow at every flood, and therefore practically in the same condition as are the rich bottom lands along the Wabash and White rivers, which Prof. Campbell tells us are thrown out as worthless, on account of the increased liability of floods in those rivers, rather than incur the necessary expense of preventing such overflow.

To admit the truth of such a proposition is to admit the impossibility of fully reclaiming these lands at a profit. But, if we are confined to the plan of *digging* a sufficient outlet for the volume of water that *must* pass through this valley, and maintaining such channel after it is dug; and if it be true that "*the length and direction of a river are determined by natural laws, and shortening will violate these laws, and in the end will result only in defeat,*" then the prospect of profitably reclaiming these lands is not encouraging. If, however, we begin "*damming,*" as well as *digging*, these lands may be *fully* reclaimed at a cost comparatively light. This method, as applicable to other river bottoms in this State, is so clearly described by Prof. Campbell in the paper before referred to, that I can not do better than copy his description here:

"LOW LANDS."

"The third class of marshes in this State includes the low lands, which exist in limited areas along the larger streams of the State, chiefly where these streams empty into other and larger ones, and also in the region which borders on Lake Michigan.

"The river marshes are the result of the overflow of the rivers themselves, and the obvious remedy is in damming and

not in ditching. Usually the soil is sandy, and consequently will be rapidly drained by absorption and evaporation if the encroachments of the river are prevented.

"But here a new engineering problem is presented. The tile drainage of the farms, the hundreds of miles of open, straight ditches, the removal of the heavy undergrowth, and the clearing out of the channels of the creeks, have destroyed the storage reservoirs which kept up the water supply for our rivers and have reduced their average size to less than half what they were sixty years ago. No commission in our day would select the site of the State capitol where it now is on account of the navigable importance of White river.

"These surface improvements, however, have so increased the velocity of all the tributaries, from tile drain to the creek, that the carrying capacity of the river is overtaxed and the danger from floods is greatly increased.

"The beds of the rivers have also received a large amount of material from the lateral streams, so that the original channels are partially filled. This also adds to the danger from freshets.

"These floods, of late years, have diminished the value of bottom lands along the Ohio, Wabash and White rivers, and many tracts, once farmed, are now thrown out as worthless.

"The recovery of these lands, and the general drainage of the low lands along the rivers, is of very great importance, and is also entirely practicable.

"The proper improvement of a river requires that its double character be recognized—its ordinary flow and its flood.

"The ordinary flow within its banks, with its graceful windings and gentle current, is the river which needs no care except to move the driftwood and beautify its banks. The straightening of this channel is vandal engineering, and in the end will result only in defeat. The length and direction of a river are determined by natural laws, and shortening will violate these laws only to create disturbance where now are repose and stability.

"The flood may be characterized as another river over the

ordinary one. This second river is temporary in character, and should be gotten rid of as speedily as possible. For this flood river as straight a channel as possible should be made, and an earnest god-speed to the parting guest provided.

"The proper provision evidently is the construction along the general line of the ordinary river of open and straight channels of sufficient capacity for the floods. The bottom of this flood river is the level of the ordinary banks in the valleys, and the protection necessary is in new banks or levees in as direct lines as possible far enough from the ordinary banks to furnish ample space for the upper river.

"It is easy to calculate the capacity required on the basis of the highest floods heretofore experienced, and have the lands outside the flood banks relieved from all danger of overflow.

"The error frequently committed is in the attempt to confine the stream to the ordinary channel by raising the adjacent banks. This error is even worse than the other already referred to in the straightening of the ordinary river.

"The whole theory may be stated in a single sentence: First, let the natural channel alone; second, make the flood channel as straight as possible, and with capacity in excess of the highest freshet hitherto experienced.

"Attention to these primary principles possibly might be of service in the improvement of the Mississippi.

"After the overflow of the river has been prevented, the adjacent marsh lands will generally become tillable, and in some cases, in localities where lands are very valuable, the Dutch method of drainage by pumps and wind-mills may be employed."

I can see no good reason that the same method, with modifications to meet the change of conditions, can not be applied, with the best of results, to the Kankakee valley, especially to the lower portion of it.

Beside the improvement along the river, which would include a clearing out of drift and other obstructions to the flow, and possibly cutting off a few bends, as well as the con-

structions of the levees for the flood channel, it would be necessary to construct large catch-drains and perhaps dykes along the edges to prevent the water from higher lands flowing over the marsh. Dredge ditches running with the general direction of the slope would afford ample drainage for the enclosed lands during *all stages* of water. It might be necessary to dike both sides of the lower end of these ditches for a short distance. Generally these ditches may be located so that the earth excavated from them may form the dike for the flood channel, thus effecting a large reduction in the cost of the work.

Some of the advantages of this system over the one heretofore proposed are :

First. A very *large reduction* in the cost of construction, an exact estimate of which would require a detailed examination of the ground, but it is safe to say that, whether the work contemplated be a partial or a complete reclamation, the cost will be very largely reduced, and that *complete* drainage under this system will cost *much less* than *partial* drainage under the other system.

Second. It admits of a perfect recovery of these lands, which can not be said to be entirely practicable by the other.

Third. It does away with the difficulty of controlling the large volume of water that would necessarily be concentrated in a large straight channel, which, with the fall it would have, would certainly attain a velocity inconsistent with stability in the loose sand through which it would pass. The cost of *maintenance* would therefore be correspondingly reduced. This is a matter that deserves *careful consideration*.

Fourth. This method would leave the lands in a very favorable condition to take advantage of the water flowing through the valley for the purpose of irrigation. This will not generally be considered of any importance, as the only object heretofore sought, has been to get rid of the surplus water of this region. If, however, no provision be made to utilize the surplus for the use of crops during droughts, these lands will suffer like all others for moisture in such seasons.

The frequency with which entire failure of some crops occurs, and the fact that nearly *every* year crops are cut short by lack of rain at a critical period of their growth, are beginning to attract attention to the importance of preventing these enormous losses, and steps are even now being taken to put irrigation into practical operation in some localities in this State. The tendency toward intensified farming, and the fact that irrigation will double the yield of many crops, and greatly increase all, will eventually largely enhance the value of all lands that can, with reasonable outlay, be brought under its influence. If the value of the lands of this valley, which are so favorably situated to receive irrigation, be estimated by the crops they are capable of producing, it is probable that irrigation would add as much to the value of these lands when drained, as the drainage would add to the present value. The reservoirs provided might be found to equalize the flow to an extent that would effect a considerable saving in cost of dikes and ditches, while their surfaces would evaporate large quantities of water to moisten the surrounding atmosphere and mitigate the effect of droughts, and some of them at least would afford excellent facilities for the propagation of large quantities of fish.

Fifth. This method renders the removal of the rock ledge at Momence of little importance, as the quantity of sand brought down would be much diminished and the reduction of water surface at the ledge less important than if the *digging* method were carried out, so that if the railroad company succeeds in its efforts to prevent the removal of the dams, the improvement of the marshes could still be accomplished without difficulty.

Sixth. And last, but not least, the feasibility of this method has been practically demonstrated by Mr. Clark in his plan for the improvement of the Cass farm, heretofore referred to.

I desire, in conclusion, to add that at the extreme upper end of the Kankakee and some of the tributaries, where the slope

of the marsh toward the central stream from each side is sufficient to prevent water from standing on the surface, but, on account of springs and seep-water from higher lands, muck or peat has formed to a greater or less depth, a different treatment is required. Here the Elkinton system may be applied with excellent results.

WABASH COLLEGE, }
CRAWFORDSVILLE, IND., February 25, 1892. }

I have read with great pleasure Mr. Whitten's paper on Kankakee drainage, and regard it as a valuable contribution to the as yet unsolved problem of the recovery of the Kankakee marshes.

I particularly commend his conclusions concerning the removal of the obstructions at Momence, Ill. The impression somehow exists that the removal of the rock dam at Momence is indispensable to the work in our own State.

In my report on this subject in 1882, page 23, I used the following language:

"Beyond the jurisdiction of Indiana it will be necessary to continue the improvement of the river to a point below the dam at Momence.

"A new channel, beginning a short distance from the State line and running west nearly two miles, will cut off a great bend in the river and effect an important saving in distance.

"The dimensions of this channel should be the same as in Division V, and owing to its short length it will readily adjust itself to any required size by the action of the stream itself.

"The other improvements of this division will be similar in every particular to those in Division VI, until the rock ledge near Momence is reached.

"This obstruction is a limestone ledge, which extends about one and a half miles in width, and its removal is a necessity for the proper improvement of the river.

"The increased velocity of the straightened channel above will carry down large quantities of soil and sand, for which a free outlet must be provided by opening a way through the rocky ledge.

"Even now the improvements in the Beaver Lake region have increased the growth of grasses and weeds in the river at Momence, and this will be further increased, to a very damaging degree, unless this free outlet is provided."

My more recent investigations as a member of the State Commission for the removal of this obstruction confirms me in the opinion that the removal is a "necessity for the proper improvement of the river" in order to furnish a free outlet to the large quantities of sand and soil which the increased velocity of the straightened stream will bring down.

If, however, the removal of this obstacle can not be accomplished, the improvement in Indiana can be carried forward, but the accumulation above the obstruction would be serious.

Mr. Whitten's proposition for dikes is worthy of most careful consideration. Whether these dikes in the sandy or porous soil along the Kankakee could be made effective is the question to be first determined. If this can be successfully accomplished, so that subterranean inlets from the river to the marsh can be closed, I do no doubt that the plan proposed would be feasible.

I most cordially welcome the suggestion as an additional plan to the one I proposed in my general report to Governor Porter in 1882.

Mr. Whitten and I would not differ materially in the details of the work to be done.

In the plan I proposed, the old channel of the river was to be utilized to the fullest extent and I would confidently expect good results by the construction of dikes. The new channel proposed for the P., Ft. W. & C. R. R. to Grand Junction I regard as essential; first, on account of the remarkable low ground along this line of the marsh nearer the river; second, to properly relieve the old channel for the added water of Yellow river.

Indeed, the plan may be characterized as the improvement of two independent rivers—the Kankakee and the Yellow—to their junction at station K, as shown on the map accompanying my report. The same may be said for the two streams from Grand Junction to station P, the one being the Kankakee as made up of the two streams at Grand Junction, and the other the tributaries on the north side along the old channel.

The remainder of my plan included substantially the improvement of the old channel to the State line and thence to Momence.

It was not intended to construct a new channel for all the water of the Kankakee valley, but to accomplish the drainage by providing additional and improved channels. To this I most willingly add the dike system proposed by Mr. Whitten so far as it can be made available.

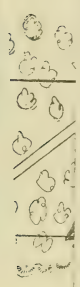
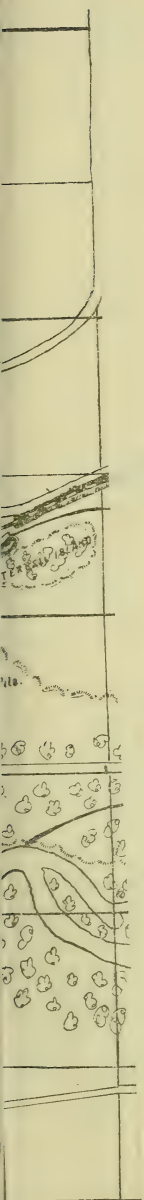
(Signed,)

J. L. CAMPBELL.

HOW I DRAINED A PIECE OF LAND.

BY J. L. CLARK, KANKAKEE COUNTY SURVEYOR, ILL.

Several years ago General Geo. W. Cass, of New York, came into my office and requested me to locate a dredge-ditch for him, on his marsh lands up the river, which, after running several lines I did, and drew the specifications for digging. Before the work was let he requested me to take full charge of it, and also of any other work he should want done in that line, and said that the problem before me was to sufficiently drain a tract of land containing about 900 acres so as to enable him to raise tame grasses upon it. "Do you think it can be done?" he asked.





Perhaps it is well to give a brief description of the land as it was when I first saw it. It was a tract of land lying nearly at the foot of a marsh containing over 600 square miles, the greater part of which was covered every spring, and usually two or three times during the summer, with varying depths of water. This tract, from causes which I will not stop to enumerate, was at the maximum point of overflow. The I. I. and I. R. R. is now on the north side. West Creek was on the east, the Kankakee river on the south, and the State line on the west side. The banks of the river, which were about eighteen inches higher than the marsh, were the highest points on the land, except the ridge on which the buildings stood. Beginning at the river and running north, I afterward found that as soon as I left the bank caused by the lodgment of sediment in overflows, it was either a dead level or a slight slope to the north till I struck the high land—the shore, as it is there called. I speak of the level as I would of the sea—in a general way—for this, like the sea, had its undulations, the ridges and the depressions varying from one foot to three feet in altitude, the lowest depressions being lower than the surface of the water in the river at ordinary stage. This was in places covered with bull-grass, so tall that a man on horseback could not see out, other places were grown up with flags, and the balance was a vast city of muskrats, whose houses, if not so palatial, were thicker than the buildings in the heart of this city. The slope of the marsh to the west is, on the average, about sixteen inches to the mile, but lies in benches running for one-half to a mile nearly level, then in a few rods dropping from six inches to eighteen inches. Every spring this was all a sea, and if, as was generally the case, the autumn fires had swept over it, made the nicest boating site conceivable. The extreme north side being lower than the rest, was covered with water three-fourths of the year, as when the waters receded it left yet a considerable amount to await the slow process of evaporation. Along the State line was a ditch reaching from river to shore, about eight feet wide on top and four feet on bottom and two feet deep, all dug with a spade.

It was as straight as an arrow and finished in perfect style. It was very dry at that time, and I knew nothing about the levels, and I really thought that it was the most perfect piece of earth-work I ever saw. I learned afterwards that it was indeed a remarkable ditch. It was both a breech and muzzle-loader, and discharged at both ends simultaneously, or alternately according to its mood. I never could conceive the object of the engineer who planned it, unless it was for the benefit of the inhabitants of the vast city spoken of. If they got in the ditch and floated with the current to the south, they could go back to their mansions and rest content, but if they floated north it was the signal to muster their forces and add another story to their domiciles. But when I took charge of its drainage, matters were not so bad. Large amounts had been expended in the attempt to drain it, but the work in that line seemed to me to consist of a bundle of sporadic efforts, with no fixed plan or purpose, and, with one exception, doing no good whatever. That exception was a dredge-ditch called the Singleton ditch, which greatly facilitated the emptying of the marsh when the river subsided. This ditch had changed the nature of the grass in its vicinity, and the ridges near it had, with very little or no success, been farmed. Still one very dry summer—I think the summer of '82—in which we had no high water from early spring until fall, they raised a splendid crop. I know that one man put in thirty acres of corn and gathered 1,500 bushels; but he gathered it in boats, the high water coming too late to materially injure the crop, but too early to gather it in the usual way. The following seasons were quite wet, and the old conditions were fast re-asserting themselves. Such was the problem before me, and when the General asked the question, "Can it be done?" I answered promptly, "Certainly it can. If Holland robbed the sea of many times that tract and pumped it dry, we can certainly rob the river of that amount and drain it the same way." "Not so, not so," he replied in that quick way of his that I had learned to interpret as meaning that he had fully considered that plan, and rejected it. "What I want is gravity drainage."

I told him that I would like to do his work, but I would not advise him to try it, as it would cost him \$10.00 for every dollar of benefit received. "It is my own money that I am expending, and if I don't complain, that ought to silence that objection," said he. "But," he added, "that is not the point; I want to demonstrate that every acre of the Kankakee marsh can be drained, and when I drain this piece I *have* demonstrated it."

I promised to take charge of his work, and began at once to collect data from which to formulate a plan. The General had promised to furnish all the means I required, and when I playfully said that I would drain it, then, if I had to build dikes to New Orleans and dig a ditch whose mouth should be at high tide, he very gravely said: "It is just such wild, impracticable schemes advanced by engineers which have done more to retard the drainage of the marsh than all other causes combined. What I want is some plain, practical plan, which in this isolated case may cost more than it comes to, but when applied to the whole marsh will come to more than the cost." The *pros* and *cons* of the situation can be briefly stated, then, as follows:

In our favor were three potent aids, in any emergency. First, a unity of interest, for the General owned all the land, and all immediately adjoining it, and to him alone, and he himself, erstwhile an engineer who in his day stood head and shoulders above the average, were plans to be submitted for adoption or rejection. Second, no lack of means. Third, the advice and counsel of Joel P. Williams, who graduated with high honors from the University of Virginia as a civil engineer, and who, by a long residence on the marsh, knew more about the behavior of the river than any other man living. The only drawback was, we must empty the water into the river, and the river was higher than the low places in the marsh. The General had talked of diking around the tract, but knowing that the soil had streaks of sand through which the water would flow almost as readily as through a sieve, and that it would only retard the water in its march

upon the land, and the benefit from that source counteracted by an equally slow process in getting rid of it, and still no way for drainage provided, I resolutely set my face against it. Run the levels as often as I chose, I could not change the contour of the land.

Many times I have regretted that I ever took hold of the work, knowing, as all engineers know, that no matter how much he may oppose any line of action, if he still retains charge of the work and it results in failure, the engineer alone must bear the burden. Summer followed spring, and autumn summer, and I had no plan. One morning in early autumn the General came into my office and asked what progress I was making. I told him, none at all, that I couldn't raise the land and I knew of no way but to lower the river, and we talked for some time about the practicability of that scheme. Unknown to me at the time, he, with his usual energy, began at once to make preparations to lay the matter before the Indiana Legislature. Winter followed autumn, and still no plan, and I concluded to lay the matter before our society and get some ideas there, and was just starting for Champaign to attend the meeting, when I received a telegram requesting me to start at once for Indianapolis and lay the matter of lowering the river before the Senate Committee, which was to meet the next day. In company with Messrs. Singleton and Kile I went down, and we secured a joint meeting of the Senate and House Committees, got a bill for an appropriation drafted, reported favorably and obtained its first and second reading, and secured the promise of enough votes to pass it upon its third reading. The day before the one set for its third reading the Legislature broke up in a row and adjourned *sine die*. Foiled again.

The greatest qualification of an engineer is not his scholarly attainments, his ability to choose the best instruments and to handle them most scientifically, but lies in his quick and accurate perception of every natural advantage, and the ready power to turn every natural force and every particle of his knowledge in his behalf, and I mention this only to

show how my failure to do this in this instance had so greatly magnified the difficulties in my path. I had as it were been trying to apply the abstruse principles of an integral calculus to a simple problem in addition, and had consequently labored like the mountain and hadn't produced the mouse.

Soon after my return from Indianapolis I bought some wood which was cut on the General's land, about one and one-half miles below the tract under consideration. The man of whom I bought it wanted to "lump off" an irregularly-shaped pile, and I went up to "survey" the wood-pile. When I got there I found the appearance of the ridge greatly changed since last I saw it, a brief two months before. The timber was all cut, the brush all piled and burned. The whole scene was now before me when before the view had been broken by the timber and quicker than the lightning's flash came the solution. I could see now that the ridge on which I stood and Terrell's island just north of me formed a narrow channel through which only could the back-water come, and that, even, must come from the mouth of Bull creek, more than a mile below me. It is true that north of Terrell's island was marsh, but at this point the broader channel and swifter current of the river had been for ages exerting its influence and given the marsh a slight slope towards the river, and I knew there was no danger from this source. I could run a levee from the ridge on which I stood up the river, and parallel with it, to West creek, then up the west bank of West creek to the railroad, and, using the railroad grade for a levee, have three sides securely diked, and the west side open for the water falling on or getting on the land to run off, and the back-water could not reach the State line.

I could see even more. The possibilities of complete under-drainage began to loom up. It was no great engineering feat to divert Bull creek by digging a dredge ditch two and one-half miles down the marsh and turn it into Trim creek, and then, by using the bank for a levee and building an additional levee of not more than thirty rods in length across Bull creek marsh, we had all the back-water shut off and an outlet

for any drainage. I had run the levels all over this ground and knew these facts before, and the fact that the key to the whole project lay two and one-half miles from the nearest and four and one-half miles from the farthest point of the land given me to drain, is no excuse, though I tried hard to make myself believe to the contrary, for my not readily finding it, and the charge must be laid where it belongs, to my innate dullness. But why J. P. Williams and General Cass, who also knew these facts, never thought of it, is one of the unaccountable mysteries.

My plan was quickly made and submitted and as quickly approved, and I was ordered to build the levee, which, as soon as the water subsided, was begun, and with all convenient dispatch completed. Soon after its completion we had high water and the little levee, more potent than old Canute, bade the incoming tide stay, and was obeyed. Up to this time there had been no talk of under-drainage, but now the General asked me about the possibility and the expense of under-draining a portion of this—about 650 acres. I gave him approximately the expense, and outlined the plan as I have stated. But we were now on the west line of his land, and this ditch two and one-half miles long must be cut on the land of outside parties. Quick to see the necessity of it, he at once set himself about the task of getting the aid, or at least the consent, of the land owners. They could not all see it in the light we did, and though the General offered all that was fair, and much more, he failed to get the right to go through. Not even his perfect courtesy, gentlemanly bearing or his four-score years could shield him from vile insult and abuse heaped upon him by one of the parties. Disappointed, but not discouraged, he told me of his failure and said I must do the best I could with Bull creek as an outlet.

I again run the levels and reported that if by beginning at the mouth of Bull creek with the dredge, we could hold it down and reach a point near Terrell island with two feet of dry bank in water at ordinary stage, and that it could be done if the ditchers would hold the dredge down, I thought I

could underdrain it in all ordinary seasons, but not in long continued wet weather. With his own hand he drew the specifications—iron-clad they were—and before he left for home had let the contract, and left me in charge. He died before the ditch was completed, but never losing sight of his pet project, he made provisions in his will for the completion of the entire plan. A delay of one year was caused by his death, but in the summers of '89 and '90 we put in the tile—about fourteen miles in all. Our main tile, at an average depth of 4.38 feet, was laid level 6,765 feet, and the balance, about 6,000 feet, on a slope of 1.6 feet to the mile. The laterals have an average depth of 3.7 feet and an average slope of a trifle more than 2 feet to the mile. Before the laying of the tile was completed, a dredge ditch 5 feet deep, 20 feet wide and 18 miles long, was dug and emptied into one outlet, which has to a considerable degree impaired the working of the tile. Still this last year, and we had high water in early May and also in the latter part of June, the man on the place harvested a good crop of oats, sowing them, when not a stone's throw away parties in boats were hunting ducks. He gathered corn fully 50 bushels to the acre, where but a few years ago the muskrats were holding high carnival; and where but a short time since the bull-frogs in one overwhelming chorus were chanting mournful melodies, cattle now chew the sweet cud of content on blue grass pastures. That the benefits are inadequate to the expense is perhaps too true. It is too much like draining an acre in a section and being obliged to drain the whole section to reach it. But how quickly and how strongly would the scale turn could the entire marsh have been embraced.

This work has demonstrated to me that many of the theories for draining this marsh are false to the core; many others utterly useless and impracticable; but it has caused to grow within me the belief that it can be done.

But I believe that to be successfully done there must be a unity of interest and a single plan, and the engineer in charge the peer of any in the land. No one party must be allowed

to undo what another does. It should be formed into a mammoth drainage district, or some other corporation having power to levy taxes, and of eminent domain sufficient to hurriedly push the work to completion. Delays in enterprises of this kind are exceedingly dangerous, causing, as they are very apt to, changes in management, engineers and plans, the almost sure precursor of failure. But with well-advised plans, able management and quick completion, I think the benefits will an hundred-fold repay the cost.

I wish to cheerfully acknowledge the invaluable aid which the fine scholarship, ripe judgment and wise counsel of Joel P. Williams afforded me, and to accord to him the credit due him for the success of the enterprise and in like manner, but in still greater degree, to that grand old man, who, with a faith never wavering and a courage never faltering, stood behind and upheld it all—General George W. Cass.

Since writing the above, a friend of mine suggests that I give the size of tile used, and state whether or not they keep clear. The original order for the two mains, to which we afterwards added 5,000 feet, principally 12-inch—the original plan having been to make an open ditch for this length—called for 7,800 feet of 15-inch; 660 feet each of 14, 13 and 7-inch, and 1,300 feet each of 8, 9, 10, 11 and 12-inch. But the 7-inch the factory was unable to furnish when we wanted them, and shipped us 8-inch instead. The laterals are 6, 5 and 4-inch, nearly equally divided. I have never examined the tile since the laying was completed, but Mr. Williams examined them last fall and reports that as far as he can learn they are perfectly clear, no obstruction of any kind being found.

Another friend suggests that I state what I think is the correct theory in regard to the drainage of the marsh. I can only do this in a general way, lacking as I do the data to particularize. A survey complete enough to make exact plans would, in my opinion, cost from five cents to ten cents per acre, or from \$20,000 to \$40,000. I made a careful cross-section of the river, just below the island at Momence, and at the narrowest point of the channel, and found that the area was in

ordinary high water 4,248 square feet, and in the extreme floods, which occur every two or three years, 4,748 square feet. Allowing over $12\frac{1}{2}$ per cent. for tributaries, it would leave 4,000 square feet of this to pass the State line in extreme high water. The fall of the river at the point of cross-section is over four feet to the mile, while at the State line with a straightened channel but a little more than one foot to the mile. This would make the current at Momence twice that at the State line, and it would therefore require a channel of 8,000 square feet to hold the water. But the north side of the marsh is lower than the marsh adjacent to the banks, and the banks eighteen inches higher than the marsh adjoining. The banks are cut with bayous and washouts, through which the marsh is flooded, while yet the greater part of the way the river is within its banks. Also, in the sluggish current, sand-bars are continually forming and other obstructions continually occurring, and to deepen the river enough to insure against overflow would require at least 4,000 more square feet. But when the marsh is drained the flood flow would be increased.

Fanning, in his work on hydraulics and water supply, gives the mean discharge in an area of 1,600 square miles of water-shed—and that is in this case the approximate amount—as 8 cubic feet per second for every square mile, or 12,800 cubic feet per second for the whole. Father Stephen, the chief engineer of the Kankakee Drainage Co., in 1871, made the mean flow at the State line 1,271 feet per second. But Mr. Fanning gives for the same area a flood flow of 59 cubic feet per second for every square mile. His formula for ascertaining velocity gives the velocity at the point of cross-section below Momence as 8.4 feet per second, which gives a discharge of only 25 cubic feet per second, or less than one-half of what Mr. Fanning says it would be when drained. Engineers can have an honest difference of opinion about the correctness of the tables or formula, but there is no disputing the fact that the Kankakee river, having two-fifths of its watershed so low that it is flooded at every heavy rain, has an

exceptional uniformity of flow, and the whole history of the drainage of large areas proves conclusively that with drainage both the maximum and minimum points of flow are pushed farther from the mean, and in the same proportion as this is done must the channel be enlarged. The average cross-section of the river in the lower part of the marsh will not much exceed 1,500 square feet, measured to full banks. To dig a channel large enough to prevent overflow, which would require one ten or twelve times as large as the river, means the expenditure of a fearful amount of money, but to do this with levees not a very formidable amount. I would therefore recommend diking the river. A large ditch would have to be dug on the north side of the marsh, and all the little streams from the north carried down the marsh, six, eight or ten miles, and then, with two parallel dikes, carried to the channel. To prevent this ditch from filling, which it would do at every heavy rain, for the streams from the north, coming as they do with a tremendous current, are heavily freighted with sediment to be unloaded at first striking sluggish water, a tract of seventy or eighty acres would have to be diked, forming an artificial lake, and a well prepared chute made to let the water into the ditch. I think in that way 90 per cent. of the sediment would stay in the tract diked, and when that tract is sufficiently filled to allow bank enough to hold the water, cut a channel through it and dike below.

With exact data before me I should probably modify this to a considerable extent, but I think the dominant idea, that of diking, would prevail. I believe it to be the only practical solution of the problem.

JOYS AND SORROWS OF THE DRAINAGE ENGINEER.

J. E. ALTER, DRAINAGE ENGINEER.

Mr. President and Brother Engineers.—I am extremely proud of the honor conferred upon me of reading a paper before this Society. There is no doubt in my mind that your time is worth more than my talent, but as that point is waived for the present I will proceed to the discussion of the subject at hand, which I will call for convenience, "Joys and Sorrows of the Drainage Engineer."

You will of course have to labor under difficulty to understand my German brogue in order to know when I mean what I say and when I say what I mean; but you know, according to the Scripture, that all mankind (which includes civil engineers) are as liable to mistakes as the sparks are to go up hill, and as engineers are especially skillful in untangling knotty questions and revealing the hidden things of nature, I trust that you will be able to translate so much of my talk into good United States as will be instructive or beneficial. I am a home-made, plain, unpretentious, uneducated, private surveyor and drainage engineer, right from the marshes and swamps of Northern Jasper. Now may be I have used the wrong word when I say surveyor. I know very well the Indians of Northern Canada would make a war dance around you if you would call them Esquimos. They do not like it. A member of the Christian church will literally baptize you with historical and scriptural argument if you but offer the single offense of calling him a Campbellite. Call a Hebrew Jew, and you will be immediately attacked by an Israelite, and I must say from what little I have heard whispered around the established corners, that a man whose business it is to change the section lines as often as possible, would much rather be called a civil engineer than a surveyor. But I leave this by you.

I like this business very well, but I have never got money enough ahead to buy me a graduate from them colleges where they keep diplomas for sale. I have some of the practical but very little of the theoretical part of the work. I can level a transit, take a course, and know how much the needle lacks of pointing where the neighbors want it to, but I can't explain how I done it. I can run a line, but I can't give a scientific explanation to the people why I missed the corner so far. I can survey a section quicker than any graduate what never had any practice, but I can't give a theoretical analysis of the work when it is done. When the drainage business first took the boom in our county, everybody thought that if one county ditch is good, 100 ditches is better, and of course 300 ditches is best. So they ordered ditches located by the wholesale, and the result was, as we would say in the old country, the citizens of Jasper county bit off more than they could chew.

This made bad work for the engineer and drainage commissioner. Here was all the petitioners prostrated by an overdose, and no antidote on hand. Some were cut down as the grass of the field, and passed over the board of trade into the vortex of ruin. Others were simply stunned by the blow, and revived again. Then there was all the ditches, some hanging on the commissioners, some hanging in the circuit court, and some slipped the rope and didn't hang at all. The effect of this unlucky business was to make everybody sour; his pocket-book was empty, his spirits was down to the freezing point. Some survived the shock, and others sold out and left the county, claiming that their poverty was a mark upon them, like the one on Cain and Abel—"a punishment on them and their children even to the third and fourth generation"—for dabbling in ditches.

But the survivors turned out to be a war-like nation. They put me in the shape of Cæsar crossing the Rubicon, or Bonaparte crossing the Alps. They crossed the Iroquois river in solid phalanx, took possession of the court-house, and used it as their citadel, and as no other enemy was in sight the engi-

neer and ditch commissioners received the whole volley right in the face. This, of course, threw them into confusion. They saw that the infuriated mob was rushing on over the floating sod of discontent, causing the ground to shake in such a manner that it was impossible to adjust their instruments. The little corps fired a few farewell shots and retreated to the barrens among the sand-hills of the north, covering their retreat with the broad cat-tail marshes that intervene between. After the smoke of battle had cleared away and the god of passion had stepped down from his throne and went over into the next county to set up his kingdom in the hearts of the children of men over there, a treaty of peace was signed, and the good farmers of Jasper county returned to their homes concluding that in the *course* of human events it is best to let nature have her *course*, of *course*. Yet this old feud has never entirely been forgotten. You can hear its echoes rattling first from one bearing and then from another, like a 4-rod chain in the hazel brush.

I remember a circumstance connected with my ditch work. An infuriated old Irish granger came out and objected in real old St. Patrick terms to my locating a ditch across his marsh land. You better believe he read his field notes to me in great shape, and he says, "If I had a lawyer here I'd have you prosecuted on the spot." He was like the Irish horse-trader (in heaven)——

Besides the stubborn points in the genus homo, we have other drawbacks in this business. When a man goes splash, splash through the water and high grass all day he is tired enough, but we must add to this the incidents and accidents of the day, such as frogs jumping up his breeches legs or down his rubber boots; big ugly snakes wrapping around his ankles, sending out their forked tongues in a threatening way; snapping-turtles pecking away at his boots; falling down over tussocks, and running the level into the mud; scared half to death by a thunder-pumper jumping up by his side; scratched his face all bloody on a limb; get his level-book all wet in a rain-storm; sun-struck in summer, frost-bit

in winter, broke through the ice and gets his rubber boots full of water seven miles from any house. Then last, but not least, you are provided with a new and green set of hands every other day. They break your chain, lose the chain-pins; you start them cutting north through the grove. They cut right on around to the right, making a circular race-track, till they get out of sight, and then come running back to see why you don't follow on around. They make the bench mark on the wrong side of the tree; make the station stakes shorter and smaller each load across the marsh; where the grass is five feet high they are left sticking above the surface about four inches, and the next fall you can't find them with a microscope. When you go to level up on floating sod they come running up like a stampede of buffalo to see how it's done, and want to know if the knives in their pockets draw the level so it won't settle. I remember surveying with a Polander——

But there is also a bright side to the picture, which I will now briefly describe, and then I'm done: You start out on a bright spring morning with a jolly set of hands. They understand their business, you give them a few words of instruction and the axmen fall to with a hearty good-will and soon lay the forest low along the proposed line of the ditch. The chainmen throw out their chain, you give them the course, and soon a lovely straight line of three-foot stakes, well marked, stand like magic sentinels, or as so many foot-prints on the sands of time.

The birds are singing in the groves, the sun shines brightly, the frogs sing gaily in the ponds; the grass grows green all around you; the bees hum amid the flowers; the prairie-chickens crow and cackle; the thunder-pumper shouts *Josephus*; the pheasant rumbles in the thicket; the squirrel barks in the trees. All nature seems to be alive, and your heart is glad.

No other specialist has so good a chance to study all nature, along with his business, as the drainage engineer. He sees a new flower, plucks it, pockets it, and, when opportunity

affords, analyzes it. He must needs study botany to some extent to be able to give an intelligent description of the kind of trees used for benches and bearings. In geology he studies the boulders, clays, shales, sand-stone and lime-stone ledges, that he may make intelligible field-notes.

I, for one, am proud of the position, and am desirous of increasing my little stock of information in this branch of business. And sometimes, when my soul is filled with the love of nature, I feel like exclaiming, as Daniel DeFoe said Alexander Selkirk did to Robinson Crusoe when left on the island alone, "I am monarch of all I survey." Thank you.

THE JOINTS OF AMERICAN VITRIFIED SEWER PIPE.

BY MALVERD A. HOWE, C. E., PROFESSOR OF CIVIL ENGINEERING IN ROSE POLYTECHNIC INSTITUTE.

From a sanitary point of view the joints of all sewer pipes should be water-tight, in order that the sewage may not escape and pollute the surrounding soil. It is not necessary that the joints be able to withstand any appreciable hydrostatic pressure, as sewers are usually designed to run but about half full. If vitrified pipe is used to convey water, the same requirement is necessary. When the pipe is laid on the hydraulic grade line, the joints are not subjected to any hydrostatic pressure, other than that due to the depth of water immediately over the joint, hence the joints need to be only sufficiently tight to prevent leakage.

Under the conditions outlined above, the only requirement at the joints is tightness against leakage; but there are many places where vitrified pipe might be used to advantage, provided the pipe itself and the joints could be relied upon to

resist hydrostatic pressure. For example, it is sometimes necessary to carry a sewer under some obstruction, as a small ravine or stream, in which case the present practice is to use iron pipe; or the pipe line between a high and low reservoir can not be located on the hydraulic grade line, and consequently the engineer hesitates to depart from the general practice of using iron pipe, although the vitrified pipe makes a much superior conduit for water.

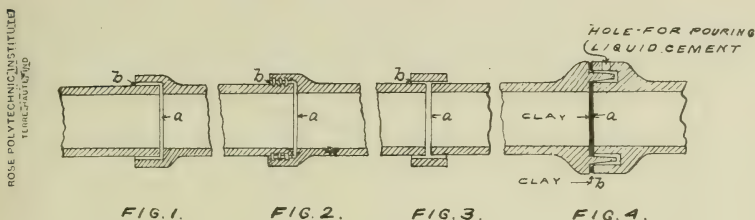
From a series of experiments recently made by the writer, he determined that the average vitrified pipe as now made will be on the point of rupture when subjected to a hydrostatic pressure of *one hundred* pounds per square inch, the average tensile strength of the material composing the pipe being *six hundred* pounds per square inch (pipes having a diameter less than twelve inches will have greater resisting power against bursting, being proportionately thicker than the twelve-inch pipe).

This pressure corresponds to a head of about *two hundred and sixty* feet, which shows that as far as safety against bursting is concerned, vitrified pipe is perfectly safe for all heads less than *fifty feet* (using a factor of safety between *four* and *five*).

The following table gives the average ultimate tensile strength of pipe of various diameters:

Nominal Diameter.	4 in.	6 in.	8 in.	10 in.	12 in.	18 in.	21 in.	24 in.
Average tensile strength, lbs. sq. in	517	678	552	702	592	529	617	856
No. of results combined . .	16	25	26	15	29	1	3	2

In conjunction with the hydrostatic tests, a series of experiments were made to determine the resistance of the joints. The following types were tested:



Type A—The ordinary bell and spigot joint as shown in Fig. 1.

Type B—The corrugated bell and spigot as shown in Fig. 2.

Type C—The ring joint as shown in Fig. 3.

The following table gives the composition and size of joints and the results of the tests :

RESULTS OF THE CEMENT JOINT TESTS

MARK.	Class.	Nominal diameter in inches.	Av. thick. of cement joint in inches.	Av. depth of cement joint in inches.	Composition of Mortar.	Age of joint in days.	Pressure in pounds per square inch.	Method employed.	Remarks.
1&10	A	10	0.35	1.40	Neat Louisville B. D.	21	None	1	1 broke.
2&3	A	8	0.35	1.50	" " "	41	50.0	2	2 and 3 broke.
*4, 5&7	A	12	1.50	4.50	" " "	33	115.0	3	Joint leaked.
8&11	A	6	0.26	1.40	" " "	33	148.0	2	8 broke.
15&18	B	12	0.25	1.75	" " "	21	6.0	3	Joint failed.
27&29	B	8	0.28	1.70	" " "	16	50.0	1	27 and 29 broke.
31&34	B	6	0.44	1.65	1c. 2s by wt.	14	None	2	Joint failed.
45&46	C	12	0.44	1.85	Neat Louisville B. D.	28	17.5	3	" " "
51&53	C	8	0.50	1.80	" " "	21	None	3	" " "
55&57	C	6	0.34	1.80	1c. 2s. by wt.	14	None	3	Pipes injured.
77&79	D	8	0.27	1.78	Neat Louisville B. D.	21	17.5	3	Joint failed.
83&85	D	6	0.34	1.63	" " "	21	25.0	3	" " "
108&112	G	12	0.50	1.83	" " "	21	12.0	3	112 broke.
123&126	G	6	0.34	1.75	" " "	21	17.5	3	123 " "
143&147	H	8	0.56	1.90	1c. 1s. by wt.	6	12.0	3	Joint failed.
148&150	H	6	0.30	1.80	" " "	6	25.3	3	" " "
†315&316	P	12	0.24	3.05	Neat Louisville B. D.	6	37.5	3	316 broke.

* Ring joint, † Improved joint—bell and spigot corrugated.

In methods numbers one and two, the pipe was prevented from moving longitudinally by clamps; and in method number three, the pipes were prevented from moving away from each other longitudinally only by the friction in the joints.

From the table, it is seen that when method number three was employed, no great hydrostatic pressure could be applied

before the joint failed, the maximum pressure for Type A being 25.3 pounds per square inch, which corresponds to a head of about *fifty-eight feet*, making the joint about one-fourth as strong against failure as the average pipe. In these experiments, when the joint failed, the pipes were usually forced apart by water entering the space (a) Fig. 1. It is noticeable from the table that the space to be filled with cement is quite variable for pipes of different makes, and in nearly every case too small to insure a full joint without great care being exercised.

A single experiment was made with corrugated bell and spigot, method number three being employed. The space to be filled with cement, and the corrugations, were so small that it was impossible to fill the joint with cement mortar, but even then the joint proved stronger than any of Type A. Although one experiment does not furnish sufficient ground upon which to base an opinion, yet the behavior of the joint during the experiment, leads the writer to believe that such a joint can be made which will be as strong as the average pipe, and preventing not only leakage, but any tendency to separate.

One experiment was also made with the ring-joint, using method number three. The joint proved to be much stronger than any mentioned above, and stronger than the average pipe. This joint was carefully made with an unbroken ring, and doubtless would have held until the pipes broke had not water entered the space (a). The joint has the advantage of plenty of space for cement, it being much thicker and longer than in Types A and B.

With Type A and method number two, even greater strength was found, showing that the pipe must be prevented from moving longitudinally.

From the results of these experiments it is evident that Type A can not be used under a hydrostatic head, the space for cement being too small and there being no means of preventing longitudinal movement otherwise than the friction of the cement and pipe.

Type B is an improvement over Type A, but the space for the cement and the corrugations should be larger.

Type C is a good joint to prevent leakage, but is not reliable under hydrostatic pressure. The joint could be improved by corrugating the ends of the pipe and the inside of the ring.

There is an English joint which is superior to the American joints, both in filling with cement and tightness. It is called "The Archer Improved Water-tight Joint." The essential features are shown in Fig. 4. The joint is filled by pouring liquid cement into the hole at (c), thus insuring a full joint. If water enters at (a), the pipes will be forced apart as in Types A and C, so that this joint is not perfect, requiring the improvement which will prevent longitudinal movement in the joint. The writer will leave this improvement for the inventive mind of some reader.

BRICK GUTTERS.

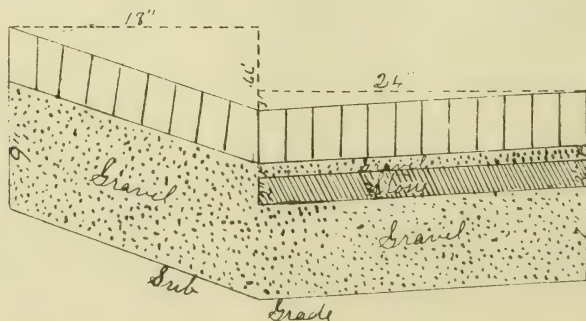
A. W. SMITH, CITY ENGINEER, KOKOMO, IND.

In many respects, brick gutters for the margins of street roadways are greatly superior to the old type of bouldered gutters. The latter are rough, unsightly, retard the flow of water, collect filth, and are hard to clean. If a boulder is loosened or displaced, the adjoining stones will fall out one by one, until the gutter is destroyed. In Kokomo, we put in the first brick gutters in 1889, during which year about 1.25 miles were built. In 1890, five miles of this class of work was done, and in 1891, two miles, very little work being done during the latter year, except what was carried over from 1890. Our first gutters were designed with a channel width of 3.5' an extreme width of 5.0' and a depth of 0.75' from the curb line. The outside, or that portion of the gutter adjacent to the macadam, was 3.0' wide, with a cup of 0.2'. Two bricks were used, alternate ones of the upper course being two inches longer than those adjacent, thereby breaking joints. For the outer portion of the gutter (adjacent to the roadway), the brick were laid on edge, at right angles with the line of the

gutter without breaking joints. Latterly, I have been constructing gutters by laying brick lengthwise and edgewise, as follows: Upon the sub-grade, which has been previously excavated to the proper line, is spread good, clean gravel, to a depth of 0.6', over which are laid flat stone about 2" thick (brick laid flat would answer the same purpose when stone is not convenient). Upon this stone surface is spread screened sand to a depth of 2", and upon the sand are laid good, extra hard-burnt brick, two rows of the same to be beveled $\frac{5}{8}$ " each, the beveled brick to be laid adjacent to the curb line. For the curb, a row of brick laid on edge is used, with the long axis parallel to the gutter line. This gutter is 3.5' wide. The outside, or that part next the roadway, is 2' wide, with a cup of 0.1'. The bottom of the gutter is 1.5' wide and 0.66' deep, measured from the curb line. After the brick have been laid, tamped, and inspected by the City Engineer, the gutter is covered with fine gravel, which is thoroughly worked into the joints with a wire broom. I believe that broken stone (macadam size) would be preferable to gravel for the foundation, the use of which would admit of leaving out the flat stone (or brick laid flat). The stone should be thoroughly tamped, and a cushion of screened sand laid on top for the brick to rest upon.

We find that a brick gutter is more easily kept in repair, cleans itself readily, does not catch filth, and when cleaning is necessary it is easily done.

Such a gutter as I have described, a cross-section of which is shown in Fig. —, can be constructed for about 55 cents per lineal foot.

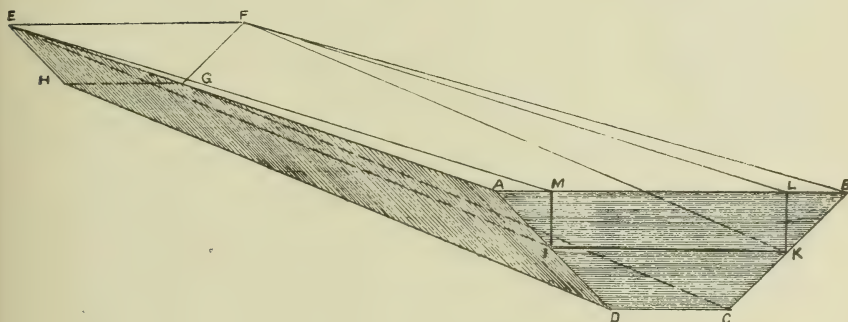


We have one brick gutter in Kokomo, 75' in length, with a stone curb, laid in 1889 by the property owner, using gravel without the stone or flat brick, that gives good satisfaction.

I think that any gutter, whether brick or bowlders, should have a common drain-tile, about 2.5' below the bottom of the gutter.

EARTH-WORK CALCULATIONS.

BY JNO. F. MEIGHAN, SOUTH BEND, IND.



Civil engineers the world over have more or less to do with computations of earth-work. The usual methods are—

1. Calculations by averaging end areas;
2. Calculations by the middle areas;
3. Calculations by mean proportionals;
4. Calculations by the prismoidal formula.

Rule for calculation by averaging end areas: Multiply the half sum of the extreme ends of the prismoid by its length. This method is correct only when the two end areas are equal.

In a tapering prismoidal mass, such as shown in perspective by above figure, having unequal end heights, a dissection of same—considering A B C D area of largest end, and E F G H area of smallest end—will show, after conceiving a plane parallel to base D C G H to be passed through E F, and vertical planes through I M-E and K L-F, that the interior body of the figure

is composed of the quadrangular prism I D C K E H G F, and the triangular prism I K L M E F. There remain two pyramids A I M-E and B K L-F. Applied to the prisms the first method will give their true volume, but when applied to the pyramids, we are wrong in multiplying one-half the area of their bases by their length, for the volume of any pyramid is equal to one-third of the product of its base and altitude; hence we have by this method a result too large by the difference between a half and one-third; *i. e.*, one-sixth the product of the bases of the pyramids by their length.

In the second method, calculation by the middle areas, the arithmetical mean of the end heights is taken, the area deduced therefrom, and multiplied by the length. The rule, as in the preceding case, applies to the prisms or central part of the figure, but not to the pyramids, in that it is deficient by one-half the excess of the first method, *i. e.*, one-twelfth of the product of the bases of the pyramids by their altitude. For, let d represent the difference of the end heights, s to r the ratio of the side slopes, and l the length of the section, then their middle heights will be $\frac{d}{2}$; their middle widths will be $s \frac{d}{2}$; their middle areas will be $s \frac{d^2}{8}$; the contents of one of them will be $s l \frac{d^2}{8}$; and the two $s l \frac{d^2}{4}$. But the contents of the pyramids $= s l \frac{d^2}{3}$. The deficiency of the method will therefore be $\frac{s d^2 l}{12}$.

In the third method, calculation by mean proportionals. Rule.—Add together the areas of the two ends and the square root of the product; multiply the result by one-third the length. This method is correct only when the mass treated is a true frustrum of a pyramid, *i. e.*, that all its sides if produced would intersect in one vertex, a condition impossible with the figure under discussion, and rarely occurring in practice. It conflicts with the truth in that it treats as pyramids or thirds of prisms the wedge-shaped pieces which are halves of prisms, giving results too small, the error being greatest where one of the end areas $= 0$.

In the fourth method—calculation by the prismoidal formula—whatever the shape of the mass of earth between two

parallel cross-sections it may be divided into prisms, pyramids, wedges or frustra of pyramids, to all of which, and therefore to the entire mass, the formula may be applied.*

Henck, in his field book for engineers, gives the following problem: Given the areas of the parallel faces B and B, the middle area M, and the altitude a of a prismoid to find its solidity S.

Solution: The middle area of a prismoid is the area of a section midway between the parallel faces and parallel to them, and the altitude is the perpendicular distance between the parallel faces. If now b represents the base of any prism of altitude a, its solidity is ab . If b represents the base of a regular wedge or half-parallelpipedon of altitude a, its solidity is $\frac{1}{2}ab$. If b represents the base of a pyramid of altitude a, its solidity is $\frac{1}{3}ab$. The solidity of these three bodies admits of a common expression, which may be found thus: Let m represent the middle area of either of these bodies, that is the area of a section parallel to the base and midway between the base and top. In the prism, $m=b$, in the regular wedge, $m=\frac{1}{2}b$, and in the pyramid, $m=\frac{1}{4}b$. Moreover, the upper base of the prism= b , and the upper base of the wedge or pyramid= o . Then the expressions ab , $\frac{1}{2}ab$, and $\frac{1}{3}ab$ may be thus transformed. Solidity of —

$$\text{Prism} = ab = \frac{a}{6} \times 6b = \frac{a}{6} (b + b + 4b) = \frac{a}{6} (b + b + 4m).$$

$$\text{Wedge} = \frac{1}{2}ab = \frac{a}{6} \times 3b = \frac{a}{6} (o + b + 2b) = \frac{a}{6} (o + b + 4m).$$

$$\text{Pyramid} = \frac{1}{3}ab = \frac{a}{6} \times 2b = \frac{a}{6} (o + b + b) = \frac{a}{6} (o + b + 4m).$$

Hence the solidity of either of these bodies is found by adding together the area of the upper base, the area of the lower base, and four times the middle area, and multiplying the sum by one sixth of the altitude. Irregular wedges, or those not half-parallelpipedons, may be measured by the same rule, since they are the sum or difference of a regular wedge and a pyramid of common altitude and, as the rule applies to both of these bodies, it applies to their sum or difference.

Now a prismoid, being made up of prisms, wedges, and

*Journal of the Franklin Institute, January and June, 1840.

pyramids of common altitude with itself, will have for its solidity the sum of the solidities of the combined solids. But the sum of the areas of the upper and lower bases of the combined solids is equal to $B+B'$, the sum of the areas of the parallel faces of the prismoid; and the sum of the middle areas of the combined solids is equal to M , the middle area of the prismoid. Therefore

$$S = \frac{a}{6}(B+B'+4M.)$$

From the above it will be seen that the prismoidal formula is in harmony with the truth, and more general in its application than any other method in common use; but its application to each particular station or group of stations in works of considerable extent, involves the expenditure of time, and liability to commit error, if not through a wrong conception of the figure treated, possibly through the hurry and fatigue of the computer. Consequently any method whereby labor is lessened and accuracy increased, must necessarily be valuable. Especially is this true when treating sections which vary in their extreme heights. Any of the preceding methods applied to level sections would give correct results. But in practice, level cuttings are the exception, and finding an equivalent level section for the irregular one is often a tedious process, if, indeed, such a method is to be recommended at all, for it assumes the earth to be leveled at the ends to a height that will give a level section equivalent to the first, and that the intervening earth be so disposed as to form a plane between these level ends, thus forming a prismoid, which, however, is not always the case.

But in the case of irregular cross-sections, where the surface of the ground renders any number of levels necessary to be taken, if we conceive a series of vertical planes to pass through all the points on each cross-section where the transverse slope of the ground changes and to cut the other cross-section so as to divide the widths of the two proportionally, then the prismoidal rule may be used, no matter how far apart the cross-sections may be taken, so that the ground varies uniformly.

For the purpose of aiding in the calculation of earth-work,

earth-work tables have been computed, more or less useful, but generally limited in their scope on account of the inconvenience of making them voluminous enough to embrace every variety of slope, base, and depth. It is therefore no uncommon practice for engineers to make such tables as they may need, when not found in the books. On this account, the writer has undertaken the compilation of a set of tables, a page of which is shown herewith.

The numerals at the top and side represent the heights of the cutting or filling at its ends. The numbers in the body of the table indicate the number of cubic yards in the slopes for the corresponding depths, for a longitudinal distance of 100 feet, which divided by 100 will give the number in the distance of one foot. The cubic yards are calculated for each foot and tenth of a foot from 0 to 100 feet; for slopes, 1 to 1 and $1\frac{1}{2}$ to 1; any other slope may be derived by multiplying the numbers in the column of 1 to 1 slope by the slope required. The third column shows the number of cubic yards in the central part, one foot wide, which, multiplied by given width of base, and added to the slopes, will give the total volume in the prismoid. The tables are computed by the prismoidal formula, and extend to three decimal places.

The tables have been computed in the following manner. For illustration we will take a table of level cuttings, both slopes 1 to 1.

FEET.	YARDS.	FEET.	YARDS.	FEET.	YARDS.
12.1	542.259	.1	736.333	.1	960.037
.2	551.259*	.2	746.814	.2	972.000
.3	560.333	.3	757.370	.3	984.037
.4	569.481	.4	768.000	.4	996.148
.5	578.703	.5	778.703	.5	1008.333
.6	588.000	.6	789.481	.6	1020.592
.7	597.370	.7	800.333	.7	1032.925
.8	606.814	.8	811.259	.8	1045.333
.9	616.333	.9	822.259*	.9	1057.814
13.0	625.925	15.0	833.333	17.0	1070.370
.1	635.592	.1	844.481	.1	1083.000
.2	645.333	.2	855.703	.2	1097.703
.3	655.148	.3	867.000	.3	1108.481
.4	665.037	.4	878.370	.4	1121.333
.5	675.000	.5	889.814	.5	1134.259
.6	685.037	.6	901.333	.6	1147.259*
.7	695.148	.7	912.925	.7	1160.333
.8	705.333	.8	924.592	.8	1173.481
.9	715.592	.9	936.333	.9	1186.703
14.0	725.925	16.0	948.148	&c.	&c.

It will be observed that the decimals 12.1 and 12.2 are each .259*. The next place where they occur together is at depths 14.8 and 14.9. They occur again at depths 17.5 and 17.6. Now the decimals included from depths 12.2 to depths 14.8, are repeated from 14.9 to 17.5. These series contain 27 numbers each. The law of the series having been thus determined, we may extend a table of level cuttings to any extent desired so far as the decimals are concerned, with perfect accuracy, by simply repeating the series. They are recurring.

In regard to determining the number of cubic yards in a cutting of any given depth from the proposition that similar triangles are proportional to the square of their homologous sides, the volume of a figure 12.2 deep, slope 1 to 1, would be four times the volume of 6.1 or $\frac{1}{2}$ the depth. The volume for 12.4 feet deep would be four times as much as for 6.2 deep, and so on. By this method every other number is obtained as the table progresses. The intervening number is obtained thus: Suppose we wish to obtain the number for the depth 12.3. The decimal part from what we have above learned has already been written out, being a repetition of the same decimal in the preceding series. Now add together the integers of the preceding and succeeding numbers and divide by two to the nearest quotient figure, and the correct whole number will be obtained. In this case the sum of the preceding and following numbers,—not regarding the decimals—is $\frac{551+569}{2}=560$ which, prefixed to the decimal .333 completes the number required, *i. e.*, 560.333.

Now, the same method may be employed, no matter what the end heights may be, or to what extent the table be carried. Of course, the series will vary, owing to the form of figure treated, whether it be a prism, pyramid or other kind; but the law still holds good. Each series in the case of the pyramid will have three times as many numbers as the prism, *i. e.*, 81; a triangular pyramid being the third part of a triangular prism having the same base and the same altitude. In each case, numbers may be interpolated without fear of error even in the final figure. Indeed, writing out the

decimals first is simply a clerical affair, and they then serve as a check upon subsequent operations, for should there be error, it will be detected in the interpolations. An immense amount of labor by the foregoing methods may be avoided in the computation of earth-work tables. So far as I have investigated, I am satisfied that this method may be employed not only in pure analysis and geometry, but in various other subjects of mathematical inquiry and computations.

TABLE OF CUTTINGS IN PRISMOIDS.—SECTIONS, 100 FEET.

HEIGHT IN FEET 2.4.										HEIGHT IN FEET 2.5.										HEIGHT IN FEET 2.6.									
Height in Feet.			Vol. in Cu.			Height in Feet.			Vol. in Cu. Yds. Both Slopes.	Vol. in Cu.			Height in Feet.			Vol. in Cu.			Vol. in Cu. Yds. Both Slopes.	Height in Feet.			Vol. in Cu.			Height in Feet.			Vol. in Cu. Yds. Both Slopes.
1 1/2 to 1	1 to 1	1 ft. w	Yds. Slopes.	Cent.	Part.	1 1/2 to 1	1 to 1	1 ft. w		Yds. Slopes.	Cent.	Part.	1 1/2 to 1	1 to 1	1 ft. w	Yds. Slopes.	Cent.	Part.		1 1/2 to 1	1 to 1	1 ft. w	Yds. Slopes.	Cent.	Part.	1 1/2 to 1	1 to 1	1 ft. w	
1	8.574	5.716	4.074	4.259	4.444	5.1	76.166	50.777	13.333	1	9.388	6.259	4.259	5.1	77.907	51.938	13.518	1	10.240	6.827	4.444	5.1	79.685	53.123	13.704	1	10.240	6.827	4.444
2	9.019	6.012	4.259	4.444	4.630	2	78.462	52.308	13.518	2	9.851	6.568	4.444	2	80.222	53.481	13.704	2	10.722	7.148	4.630	2	82.018	54.679	13.889	2	10.722	7.148	4.630
3	9.500	6.333	4.444	4.630	4.815	3	80.796	53.864	13.704	3	10.351	6.901	4.630	3	82.574	55.049	13.889	3	11.200	7.494	4.815	3	84.388	56.259	14.074	3	11.200	7.494	4.815
4	10.018	6.679	4.630	4.815	5.000	4	83.166	55.444	13.889	4	10.888	7.259	4.815	4	84.962	56.641	14.074	4	11.796	7.864	5.000	4	86.796	57.864	14.259	4	11.796	7.864	5.000
5	10.574	7.049	4.815	5.000	5.185	5	85.574	57.049	14.074	5	11.462	7.642	5.000	5	87.388	58.259	14.259	5	12.388	8.279	5.185	5	89.240	59.493	14.444	5	12.388	8.279	5.185
6	11.166	7.444	5.000	5.185	5.370	6	88.018	58.679	14.259	6	12.074	8.049	5.185	6	89.851	59.901	14.444	6	13.018	8.679	5.370	6	91.722	61.148	14.630	6	13.018	8.679	5.370
7	11.796	7.864	5.185	5.370	5.555	7	90.500	60.333	14.444	7	12.722	8.481	5.370	7	92.351	61.567	14.630	7	13.685	9.123	5.555	7	94.240	62.827	14.815	7	13.685	9.123	5.555
8	12.462	8.309	5.370	5.555		8	93.018	62.012	14.630	8	13.407	9.038	5.555	8	94.888	63.258	14.815	8	14.388	9.593	5.741	8	96.796	64.531	15.000	8	14.388	9.593	5.741
9	13.166	8.778	5.555			9	95.571	63.716	14.815	9	14.129	9.420	5.741	9	97.462	64.975	15.000	9	15.129	10.086	5.926	9	99.388	66.259	15.185	9	15.129	10.086	5.926
1	13.907	9.272	5.741	5.926		6	98.166	65.444	15.000	1	14.888	9.926	5.926	6	100.074	66.716	15.185	1	15.907	10.605	6.111	6	102.018	68.012	15.370	1	15.907	10.605	6.111
2	14.685	9.790	5.926	6.111		7	100.796	67.197	15.185	2	15.685	10.457	6.111	7	102.722	68.481	15.370	2	16.722	11.148	6.296	7	104.685	69.790	15.555	2	16.722	11.148	6.296
3	15.500	10.333	6.111	6.296		8	103.462	68.575	15.370	3	16.518	11.012	6.296	8	105.407	70.271	15.555	3	17.574	11.716	6.481	8	107.388	71.532	15.741	3	17.574	11.716	6.481
4	16.351	10.901	6.296	6.481		9	106.166	70.777	15.555	4	17.388	11.938	6.481	9	108.129	72.086	15.741	4	18.462	12.309	6.667	9	110.129	73.419	15.926	4	18.462	12.309	6.667
5	17.240	11.494	6.481	6.667		10	108.900	72.605	15.741	5	18.296	12.193	6.667	10	110.888	73.925	15.926	5	19.388	12.966	6.852	10	112.907	75.271	16.111	5	19.388	12.966	6.852
6	18.166	12.111	6.667	6.852		11	111.685	74.577	15.926	6	19.240	12.871	6.852	11	113.685	75.790	16.111	6	20.351	13.568	7.037	11	115.722	77.148	16.296	6	20.351	13.568	7.037
7	19.129	12.753	6.852	7.037		12	114.500	76.333	16.111	7	20.222	13.481	7.037	12	116.518	77.679	16.296	7	21.351	14.295	7.222	12	118.574	79.049	16.481	7	21.351	14.295	7.222
8	20.129	13.420	7.037	7.222		13	117.351	78.234	16.296	8	21.240	14.160	7.222	13	119.388	79.592	16.481	8	22.462	15.036	7.407	13	121.462	80.975	16.666	8	22.462	15.036	7.407
9	21.166	14.111	7.222	7.407		14	120.240	80.160	16.481	9	22.296	14.861	7.407	14	122.296	81.531	16.667	9	23.574	15.983	7.592	14	124.388	82.975	16.851	9	23.574	15.983	7.592
	22.240	14.827	7.407				123.166	82.110	16.667		23.388	15.593	7.592		125.240	83.493	16.852		24.574	16.383	7.778		127.351	84.901	17.037		24.574	16.383	7.778
2	23.351	15.568	7.592			7	126.129	84.086	16.852	2	24.518	16.345	7.778	7	128.222	85.481	17.037	2	25.722	17.148	7.963	7	130.351	86.901	17.222	2	25.722	17.148	7.963
3	24.500	16.333	7.778			8	129.129	86.086	17.037	3	25.685	17.123	7.963	8	131.240	87.493	17.222	3	26.907	17.938	8.148	8	133.388	88.925	17.407	3	26.907	17.938	8.148
4	25.685	17.123	7.963			9	132.166	88.111	17.222	4	26.888	17.926	8.148	9	134.296	89.531	17.407	4	28.129	18.753	8.333	9	136.574	90.975	17.592	4	28.129	18.753	8.333
5	26.907	17.938	8.148			10	135.240	90.160	17.407	5	28.129	18.753	8.333	10	137.588	91.592	17.592	5	29.388	19.593	8.518	10	139.974	93.049	17.777	5	29.388	19.593	8.518
6	28.166	18.778	8.333			11	138.351	92.234	17.592	6	29.407	19.605	8.518	11	140.518	93.679	17.778	6	30.685	20.457	8.704	11	142.722	95.148	17.963	6	30.685	20.457	8.704

5.29.462 19.642 8.518	5.141.500 94.333 17.778	5.30.722 20.481 8.704	5.143.685 95.790 17.963	5.32.018 21.346 8.889	5.145.907 97.271 18.148
6.30.796 20.531 8.704	6.144.685 96.457 17.963	6.32.074 21.383 8.889	6.146.888 97.925 18.148	6.33.888 98.259 9.074	6.149.129 99.419 18.338
7.32.166 21.444 8.889	7.147.907 98.605 18.148	7.33.462 22.309 9.074	7.150.129 100.086 18.333	7.34.796 23.198 9.259	7.152.388 101.592 18.518
8.33.574 22.333 9.074	8.151.166 100.777 18.333	8.34.888 23.259 9.259	8.153.407 102.271 18.518	8.36.240 24.160 9.444	8.155.685 103.790 18.704
9.35.018 23.346 9.259	9.154.462 102.975 18.518	9.36.351 24.235 9.444	9.156.722 104.481 18.704	9.37.722 25.148 9.630	9.159.018 106.012 18.889
3.0 36.500 24.333 9.444	8.0 157.796 105.197 18.704	3.0 37.851 25.235 9.630	8.0 160.074 106.716 18.889	3.0 39.240 26.160 9.815	8.0 162.388 108.259 19.074
1.38.018 25.346 9.630	1.161.166 107.444 18.889	1.39.388 26.259 9.815	1.163.462 108.975 19.074	1.40.796 27.198 10.000	1.165.796 110.531 19.259
2.39.574 26.333 9.815	2.184.574 109.716 19.074	2.40.962 27.309 10.000	2.166.888 111.259 19.259	2.42.388 28.259 10.185	2.169.240 112.826 19.444
3.41.168 27.444 10.000	3.188.018 112.012 19.259	3.42.574 28.333 10.185	3.170.351 113.567 19.444	3.44.018 29.346 10.370	3.172.722 115.148 19.630
4.42.796 28.531 10.185	4.171.500 114.333 19.444	4.44.292 29.481 10.370	4.173.851 115.951 19.630	4.45.685 30.457 10.555	4.176.240 117.493 19.815
5.44.462 29.642 10.370	5.175.018 116.679 19.630	5.45.907 30.605 10.555	5.177.388 118.259 19.815	5.47.388 31.593 10.741	5.179.796 119.864 20.000
6.46.166 30.778 10.555	6.178.574 119.049 19.815	6.47.629 31.753 10.741	6.180.962 120.641 20.000	6.49.129 32.753 10.926	6.183.388 122.259 20.185
7.47.907 31.938 10.741	7.182.166 121.444 20.000	7.49.388 32.926 10.926	7.184.574 123.049 20.185	7.50.907 33.938 11.111	7.187.018 124.679 20.370
8.49.685 33.123 10.926	8.185.796 123.864 20.185	8.51.185 34.123 11.111	8.188.222 125.481 20.370	8.52.722 35.148 11.296	8.190.685 127.123 20.555
9.51.500 34.333 11.111	9.189.462 125.308 20.370	9.53.018 35.345 11.296	9.191.907 127.938 20.555	9.54.574 36.383 11.481	9.194.388 129.592 20.741
4.0 53.351 35.568 11.296	9.0 193.166 128.777 20.555	4.0 54.888 36.538 11.481	9.0 195.629 130.419 20.741	4.0 56.462 37.642 11.667	9.0 198.129 132.086 20.926
1.55.240 36.827 11.481	1.196.907 131.271 20.741	1.56.796 37.864 11.667	1.199.388 132.925 20.926	1.58.388 38.926 11.852	1.201.907 134.605 21.111
2.57.166 38.111 11.667	2.200.685 133.790 20.926	2.58.740 39.160 11.852	2.203.185 135.457 21.111	2.60.351 40.235 12.037	2.205.722 137.148 21.296
3.59.129 39.420 11.852	3.204.500 136.333 21.111	3.60.722 40.481 12.037	3.207.018 138.012 21.296	3.62.351 41.568 12.222	3.209.574 139.716 21.481
4.61.129 40.753 12.037	4.208.351 138.901 21.296	4.62.740 41.827 12.222	4.210.888 140.592 21.481	4.64.388 42.926 12.407	4.213.462 142.308 21.667
5.63.166 42.111 12.222	5.212.240 141.493 21.481	5.64.796 43.198 12.407	5.214.796 143.197 21.667	5.66.462 44.309 12.592	5.217.388 144.925 21.852
6.65.240 43.494 12.407	6.216.166 144.111 21.667	6.66.888 44.593 12.592	6.218.740 145.823 21.852	6.68.574 45.716 12.778	6.221.351 147.567 22.037
7.67.351 44.901 12.592	7.220.129 146.753 21.852	7.69.018 46.012 12.778	7.222.722 148.451 22.037	7.70.722 47.148 12.963	7.225.351 150.334 22.222
8.69.500 46.333 12.778	8.224.129 149.419 22.037	8.71.135 47.457 12.963	8.226.740 151.160 22.222	8.72.907 48.605 13.148	8.229.388 152.925 22.407
9.71.685 47.790 12.963	9.228.166 152.111 22.222	9.73.388 48.926 13.148	9.230.796 153.864 22.407	9.75.129 50.086 13.333	9.233.462 155.641 22.593
5.0 73.907 49.272 13.148	10.0 232.240 154.827 22.407	5.0 75.629 50.420 13.333	10.0 234.888 156.592 22.593	5.0 77.388 51.593 13.518	10.0 237.574 158.383 22.778

SOME QUALIFICATIONS OF THE ENGINEER.

BY E. B. VAWTER, CIVIL ENGINEER, LAFAYETTE.

In this short paper I wish to speak of some qualifications necessary to the engineer, not found in the text books or largely taught in the schools, and yet of prime importance in the active duties of business. And the words of this paper do not apply so much to the engineer who in his office plans large and important works, the details of which are to be carried out by others, or to the subordinate, who with little thought of responsibility, lays out the work of another, as to that large class of engineers, scattered broadcast over our land, found in every county and town of any considerable size, who have both to devise and supervise—to plan and execute—and that of every variety of work, whether it be to survey a town lot, an acre of ground or a farm; to improve streets and roads, build bridges, lay out systems of drainage for rural districts, or sanitary works for towns and cities—in short, to that class of engineers who are called upon in every county of our State to plan and carry out in detail every needed improvement.

Now this engineer in his capacity as a public servant, sustains relations to himself, to the public which he represents, to the contractor whose work he superintends, and to individuals whose private interests are affected by the work in progress. And now, as to himself, aside from pecuniary necessities—and most engineers are supposed to have such necessities—he must maintain himself as a man of honor, one who can be trusted as an honorable citizen, and as an expert whose work will do him honor.

Then he, in the management of public works, stands as a representative of the public, an agent for the public, and to him are committed matters of great public importance. Important as to cost, important as to their adaptability to the end designed, and also as to the manner of their execution,

and so he is expected to see that the means are suited to the end sought, and that the public gets value received for every dollar expended.

Then, while he thus looks to the interests of the public, he should, as far as possible, maintain amicable relations with the contractor, and in insisting that the contract should be fulfilled, it should be done rather in the spirit of "right is right," than of "might is might." In other words, while temporarily placed in a position of authority, it should not be exercised in an arbitrary or overbearing way, but rather in a spirit of stewardship. While the interests of the public are well subserved, those of the contractor should not be lost sight of, and he unnecessarily and arbitrarily burdened with things not really essential.

Again, in public enterprises there is usually some private individual who has an axe to grind, and some other one who has very tender corns. The engineer must then so run his tangent as to avoid the toes of the one and the grind-stone of the other and yet run true to the objective point. Now in view of these relations and considerations, what are the "some qualifications" referred to.

First, let me say, he should be a man of strict integrity. "Honor bright" should be his rule. He should have no market value. Gold should change his polarity of principle as little as the pure brass of his transit affects the polarity of the needle. Then he should be a man of good judgment, able to see the end to be accomplished and ready in the adaptation of means to that end. He should not be visionary, chimerical. Such a man may be useful somehow or somewhere, perhaps, but I think not in the ordinary affairs of life. In short, while not deficient in theory he should be eminently a practical man.

Then he should be a man of tact, ready to adjust himself to circumstances as they come up. Without this a man is liable to frequent collisions of more or less disastrous consequences, while by a little dextrous side-tracking these are avoided and he moves forward on an open and unobstructed way. In short, the common every-day engineer need not be

a genius, but he does need to be largely endowed with that very uncommon thing commonly called *common sense*.

President Smart—While listening to the reading of this paper I thought I would like to make a political speech on it, and I believe now that I will do it anyhow, although such speeches may be out of place in college halls. In the first place, I believe more money is wasted by bad civil engineering and by no civil engineering in our cities and towns than we are aware of. It is one of the most important things in the wide world to supervise the construction of public works, and provide for the public safety with regard to its health, drainage, and so on.

The people do not understand its value ; they do not appreciate it. The question of sanitation is a tremendous subject ; it is a profound subject, and I say that more money is wasted directly and indirectly in this way than perhaps in many other ways, and I do not see how this can be remedied so long as we elect a man to a public office and give him a short tenure. I think it is impossible. You must plan a system of drainage for a city. It must have a pretty wide sweep. It must be carried out after years of patient labor and after successive appropriations (not excessive appropriations). Take a city like Lafayette, for example. To plan a system of drainage for Lafayette would require two or three years, and to carry it out, would require fifteen or twenty years. It should be given a comprehensive study, and be so thoroughly understood, and so thoroughly worked out, and so thoroughly approved, that no man would dare to change it. But as it is, when a man has worked on such a subject two years, he has to step out and another fellow steps in. That is the political aspect of the speech I want to make. In other words, there should be no politics at all in this thing. I can not see how a second-class Democrat is better than a first-class Republican, or how a second-class Republican is better than a first-class Democrat in so important an office. I prefer a man that understands his business. In the matter of a system of drainage, I don't care whether he votes the Republican ticket or the Democratic ticket or the Prohibition ticket. [Laughter.]

I don't care whether he belongs to a church. I don't care what he is, so he is the straight up and down man that has been described in this paper, if he will give us scientific work, and do such good work that it will not have to be changed, and new plans formulated. I know how it was at Indianapolis, and within a short time ago, too. A man that works a year or two on such complicated subjects hasn't time to develop a plan. Perhaps he does the best he can and out he goes. Another man, or set of men, come in and make another plan, and out they go; and so it is year after year.

I do not say it is the fault of the engineers. Take the most competent set of men that ever occupied the position, the thing can't be done under our present system. I am in favor of electing a civil engineer for twenty-five years. [Laughter.] I would elect him for just as long as he fills the bill. Get a good man and stick to him.

If there is any politics in this speech make the most of it. I am not afraid to say it. I know that there are thousands of dollars wasted in most localities, and it must amount to millions of dollars in this State, because of this fault of which I speak. I do not know that we can change the system, but I advise you to be elected as often and as long as you can. [Applause.] You will agree with me in that at any rate. [Laughter.] Just get in and perpetuate yourself. [Laughter.] Not by "whacking up" with the fellows that have "influence," but by doing the best character of work, and that, I presume, you are trying to do. We should have civil service in these great things, which affect the public pocket and especially the public health.

Take five of the best men in the State of Indiana, and elect each for two years. Can you get the best results, even though you have the best men in the State? It can't be done. Every city has its own system. A man can not plan out a system of sewerage for Podunk and go and apply it to Lafayette. He has got to study his surroundings. He has got to study Lafayette. I don't know much about the business. I suppose plans that might fit Lafayette would not fit South Bend.

A general knowledge of surveying can be obtained from

the schools, but the particular knowledge, the precise knowledge, the knowledge of locality, is a matter for private study. You can't get that in school. A man must have time for that. How long will it take him to learn and study out a plan for the best system of sewerage for the city of Lafayette? Can he make it in a year? I don't believe he could study that thing all out in two years. He must know a great many things. I don't think he could get it up even at the end of two years; but then there comes on an election, and he goes out and another fellow comes in. We shall never get the best results and the most economical results with that sort of thing. I advise you to hold on to your positions just as long as you can. [Applause.]

Mr. Whitten—I would add an amendment: when you elect an engineer for twenty-five years, that you give him control of the subject, and not allow the member of the Common Council, for the simple reason that he received one more vote than some other man, to become, simply by reason of that vote, an expert civil engineer.

Pres. Smart—That is correct.

Mr. Whitten—Your engineer may recommend the very best system possible, but it may not be adopted by the Common Council. I think a little more power should be given the engineer.

Pres. Smart—Yes, or elect a few Mugwump Councilmen.

SPECIFICATIONS FOR STAND-PIPE.

BY A. E. PHILLIPS, PROFESSOR OF CIVIL ENGINEERING IN
PURDUE UNIVERSITY.

I can scarcely hope that engineers will find anything of interest in this paper. About one year ago I was called upon to draw up plans and specifications for a stand-pipe to be erected in connection with a water-works plant. Looking into the matter as thoroughly as was possible, I was im-

pressed with the fact that anything like completeness in the specifications for this class of work was completely wanting. The following specifications are published in the hope that they may prove useful to others.

SPECIFICATIONS.

Proposals must include all work and materials for structure complete above foundation, and must be accompanied by complete detail drawings, or blue print copies of drawings, to a scale of not less than one-half ($\frac{1}{2}$) inch to the foot, the successful bidder to leave said drawings or blue print copies with the engineer of the — Co.

Certified check to the amount of——dollars, payable to ——, must accompany each bid.

The contractor to whom this work shall be awarded shall present in person at the office of the——Co., securities satisfactory to the company, within——days after the award and execute such further contract and agreement for the construction of the stand-pipe as may be required.

Securities to the amount of——of contract price, shall be furnished by successful bidder; said securities to be satisfactory to the——Co.

DETAIL SPECIFICATIONS.

The stand-pipe shall be built of a high grade steel plate of a guaranteed ultimate tensile strength of not less than 60,000 pounds per square inch, nor more than 65,000 pounds per square inch. The party or parties to whom the contract shall be awarded shall furnish the engineer of the —— Company with specimens of the plate; said specimens to be prepared by contractor for testing, in accordance with instructions of engineer in charge. The specimens shall be subjected to the following tests, viz:

1. Test for ultimate strength.
2. Test for elongation. (Specimen shall show an elongation of 25 % in eight inches.)
3. Test for reduction of area. (Specimen shall show a reduction of 40 % of area of rupture from original area.)

4. Test for hardness. (Material shall be heated to cherry red, and when suddenly quenched shall show no sign of temper.)

Specimen to be twenty (20) inches long, and of uniform cross-section in middle eight (8) inches. All plates to be stamped with maker's name and the ultimate strength of plate.

The tower shall be — feet in interior diameter from top to bottom, and — feet high. There shall be — courses, each to build — feet. Courses to be of following thicknesses : *

The bottom of tower shall be of steel-plate of the same quality as the shell, and — inches thick, and shall be connected to shell by an angle iron — x — x inches thick and riveted to bottom and to shell by double rows of rivets.*

*It is recommended to make the bottom plate of the same thickness as the bottom course of tower.

*Thickness of course to be computed by the following formula :

$$2 St = P.$$

In which t = thickness of metal, and S = safe working tensile strength of steel plate, which = 12,000 pounds per square inch. P is the interior pressure upon the walls of stand-pipe. If h = height of stand-pipe in feet, then the unit pressure at base of stand-pipe = $.434 h$. If this latter quantity be multiplied by the diameter (in inches) of the stand-pipe, we will get P = the total pressure upon the interior of the stand-pipe for each inch in height of pipe. Having determined the thickness of the metal to resist tearing along a vertical line, the material should then be examined as to its capacity to resist the crushing force due to the weight of the metal above. When the stand-pipe is empty, the wind may cause excessive strains in the metal, due to flexure. In this case, the stand-pipe acts as a cantilever. The thickness of metal necessary to withstand these strains may be found from the following formula :

$$\frac{SPt}{E} = M.$$

In this formula SP = the safe working strength of the steel plate in either tension or compression. I = the moment of inertia about a diameter as an axis; which for a hollow circular area = $\frac{1}{4}\pi(r^4 - r_1^4)$. E = the radius of cylinder in inches, and M = the bending moment, which for a cantilever under an uniformly distributed load = $\frac{wl^2}{2}$. In this last expression w = pressure of wind, in pounds, per square inch.

(For value under different conditions see Fanning's Water Supply Eng.)

l = height of stand-pipe in inches. Hence, $\frac{SEI}{E} = \frac{wl^2}{2}$, or $\frac{12,000 \times \frac{1}{4}\pi(r^4 - r_1^4)}{r} = \frac{wl^2}{2}$ or $\frac{18,857(r^4 - r_1^4)}{r} = wl^2$.

If it is found that this formula requires a greater thickness of metal than was found necessary to resist tension due to internal pressure, then the value derived from it is to be adopted.

The horizontal seams of shell above foundation shall be single riveted. All vertical seams shall be double riveted. The details of riveting shall be as follows:*

The diameter of rivets may be found from the following formula, viz.: $d = 1\frac{1}{4}t + \frac{3}{16}$ ". In this formula d = diameter of hole and t = thickness of thickest plate in inches. For single riveted joints, the pitch of the rivets should be $2\frac{3}{8}$ times the diameter of the hole. For double-riveted joints the pitch should be from 3.64 to 3.82 times the diameter of the hole. The rivets should not be nearer to edge of plate than $1\frac{1}{2}$ times the diameter (measured from edge of plate to center of hole).

The tower shall be anchored to the foundations by means of anchor bolts — in number. Each bolt shall be — inches in diameter, spaced at equal distances around the circumference of the shell and at — feet from the outside of the shell to center of anchor bolt, and shall be connected to shell by means of brackets of proper size and strength.

Tower to be set on foundation in mixture of cement and coal tar evenly distributed over the surface to a depth of — inches, and shall be finished around the edge to exclude external moisture.

The anchor bolts to pass through foundation, together with heavy cast-iron plates for bottom of foundation, shall be delivered within — weeks after award of contract.

There shall be a — inch inlet pipe with flange and elbow to be connected with bottom of tower. Length of pipe and elbow shall be such as to make connection with — inch main. Axis of said main to be — feet below upper surface of foundation. Elbow to have bell end to make lead connection with main. There shall be a man-hole — inches in diameter in center of lower plate, with seat ring riveted to lower plate with cover inside held in place by bolt and yoke.

All plates shall be coated to protect them from rust before and during erection. Stand-pipe shall be thoroughly tested before final acceptance by — Co.

For riveting iron to bottom of tower and to shell, the same methods will apply as for designing horizontal and vertical riveting.

The upper ring of tower shall be stiffened at the top by means of an angle iron —x—x— inches, riveted to the shell on the outside by a single row of rivets.

All work shall be subject to inspection by — Co., or by their authorized representative. During the process of manufacture, the plates shall be subject to inspection. The inspector shall have the right to cut a test specimen from any plate, and this specimen shall be taken as representing the qualities of the batch of plates from which the specimen plate is taken. The test specimen shall be prepared for testing at the expense of the contractor, and according to the instructions of the inspector.

During erection, all work shall be subject to inspection, and all faulty work subject to rejection. The use of drift pins for fairing rivet-holes will not be permitted. If holes do not come up fair, they must be properly reamed.

Tower shall be well caulked inside and outside, and be water-tight. Tower shall receive one thin coat of coal-tar varnish inside and outside after erection, and after drying thoroughly, the outside, together with all exposed iron-work, shall receive two coats of dark red mineral paint.*

*This section may be changed to suit the fancy of the engineer.

APPEALED SURVEY IN VIGO COUNTY.

BY JNO. T. CAMPBELL, COUNTY SURVEYOR, PARKE CO.

Mr. President—Some time last November I was appointed by the Vigo County Superior Court to make a survey in the southwest corner of Vigo county, on an appeal from the survey made by the ex-county surveyor. The corner and line specially appealed from, was corner to sections 13, 14, 23 and 24, T. 11, N., R. 10 W., and the line west between sections 14 and 23.

The land about the corner had been cleared within the past ten years, and a sandstone properly marked was in place at or near the true corner, but no witness trees supported it.

The ex-county surveyor had moved said stone south 46 links in a survey made on due notice before his term expired. He moved it to be equidistant between corners of sections one mile north and one mile south. He measured with a hundred foot steel tape, and measured twice, he told me; but my chainmen with a steel tape four-pole chain made the two miles about 65 links short. I measured three times with one change of front chainmen. The ex-surveyor made the north mile (between 13 and 14) about 30 feet shorter, and the south mile (between 23 and 24) about 60 feet longer than the call.

As the Vigo county notes showed only the corners, and "jogs" or "laps" on the township and range lines, I had to procure the full and complete notes from the Auditor of State. From these I learned that Wm. Harris had run the township and range lines, and that later Arthur Henrie had subdivided the fractional township into sections.

I first took the latitudes and departures of the meander of the Wabash river from the south boundary of the township north to the line between sections 14 and 23, and found it to agree with the section measurements within 26 links in 4 miles. This, for a United States survey, I considered good.

In running the first tier of sections (36 to 1), I found by

than the one used by William Harris, who ran the "range" line. The random east between sections 25 and 36 showed the intersection was 50 links south of post; between 24 and 25, 100 links south; between 13 and 24, 150 links south; between 12 and 13, 200 links south. From there northward the lines were run west from the posts on range line to the river. This increasing error being uniform I regarded it as reliable.

After running a random between sections 23 and 24, and correcting on the old corner at 13-14-23-24, I ran a random east between 13 and 24, at right angles to said corrected line between sections 23 and 24, and at the distance called for I intersected 153 links south of the corner to 13 and 24, where I found the stump of one original witness tree plainly marked. This, after twice crossing a pond made by the abandoned bed of the Wabash river, was within three links of what Arthur Henrie made it in 1815. This convinced me that the corner was right before the ex-surveyor moved it south; as it was within three links of where I would have located it by my survey, and I therefore restored it to the old location. I judged that the stone must have been placed there by some past surveyor at a time when the witness trees were standing. I am disposed to give my predecessors credit for knowing *something*.

Of course the line between Sections 14 and 23 would be run at right angles to the corrected line between 23 and 24, as the former line was originally run west to the river from corner to 13-14-23-24, and if line between 23 and 24 was north as called for, the west on the same declination (Var.) would be at right angles.

I am not disposed to disparage the work of the ex-surveyor of Vigo county. With the limited notes he had to work from, I might have done as he did. I give this case more to show the importance of having the complete notes than for anything else. As it is the duty of the surveyors of to-day to follow the tracks made by the original surveyors, it is important to have all the tracks of which they made record.

But even then, we will sometimes be obliged to discriminate between the original surveyors. It was doubtless with them as with some in our day. Some then, as now, took a pride in their work, and did it right. Others rushed it through and made any kind of a report that would be accepted by the Surveyor-General, drew their pay and left that locality.

Surveying to relocate old lines and corners becomes more difficult every year. But, as land also becomes more valuable by time, the surveyor is likely to be wanted as long as land is held in severalty.

NOTE: In 1843 Nathan L. Squibb was ordered to resurvey the east tier of sections (by what authority I know not) and carefully meander the ponds called in the notes "Grassy Ponds." They are the abandoned beds of the Wabash river, partly filled by sedimentation. Mr. Squibb's chain was .00188 longer than that used by Wm. Harris, as he made 79.85 chains cover Harris's 80 chains; and it was .0044 longer than that used by Arthur Henrie, or 79.65 chains for 80 chains. Squibb's plat of the ponds was so different from that of Henrie's as to appear to be a different survey. The dotted boundary of ponds is by Henrie. The solid boundaries by Squibb, as shown on the plat accompanying this text.

REPORT OF COMMITTEE ON NECROLOGY.

Mr. President--Your Committee on Necrology report as follows:

Our Society has been called upon to mourn the death of a brother distinguished for his ability, integrity and well-known devotion to the cause of surveying and civil engineering. We, your committee, therefore offer the following resolutions:

RANSOM H. WALLS.

Ransom H. Walls was born in the city of Greencastle, Ind., June 19, 1853, and died at Bloomfield, Ind., Nov. 9, 1891.

Mr. Walls was a successful school teacher for a number of years, when he entered the field of surveying and civil engineering, which calling he followed with marked success and ability until his death.

He was a charter member of the Association of Civil Engineers and Surveyors of Indiana, and was twice elected President of the Society, which office he filled with great credit to himself and satisfaction to the Society. He was an ever-ready and faithful member, willing at all times to do what he could to advance the interests of the Association. Therefore, be it

Resolved, That since it has pleased the great Engineer of the Universe to strike down and remove from our midst our fellow member, we sincerely deplore his death. And be it further

Resolved, That this Society extends its most profound sympathy to his bereaved wife and family in this, their great loss. And be it further

Resolved, That in his death this Society has lost a faithful and efficient member, whose presence and ability will be sadly missed at our meetings. And be it further

Resolved, That a copy of these resolutions be forwarded to the wife and family of our deceased brother, and that this report be printed in the proceedings of this Association.

J. F. O'BRIEN,

C. G. H. GOSS,

L. S. ALTER,

Committee.

NOTE.—The Committee on Necrology was not sufficiently informed on the death of the other members as reported, and therefore, for want of data, deferred reporting until the next meeting of the Society.

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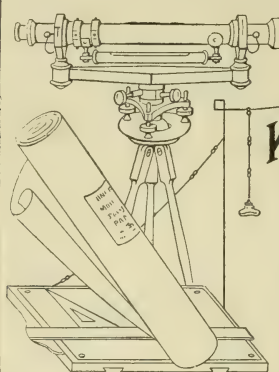
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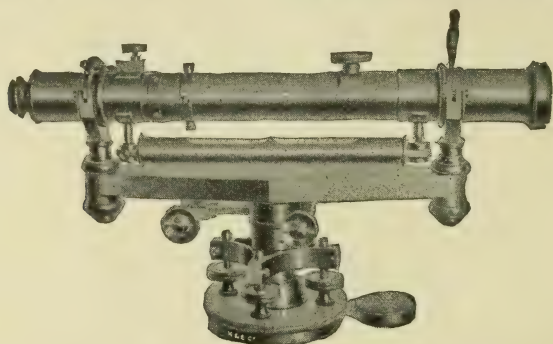


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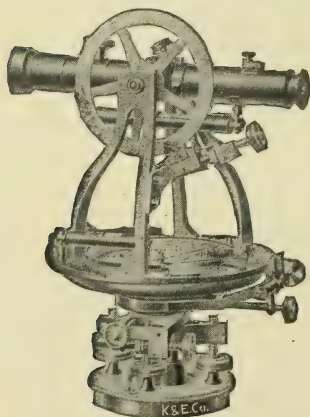


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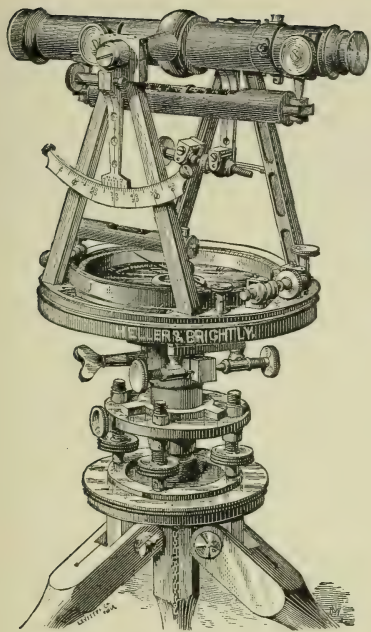
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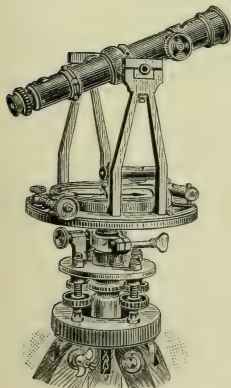
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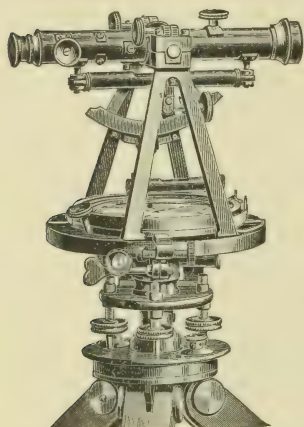
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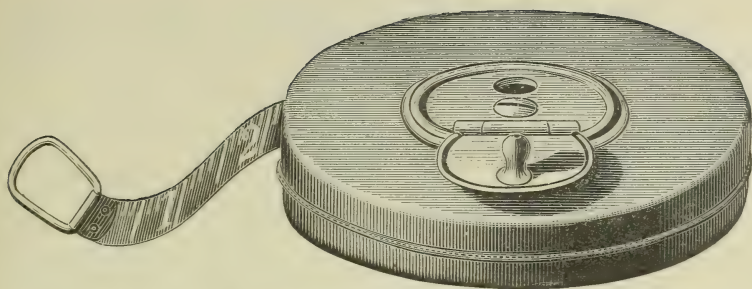
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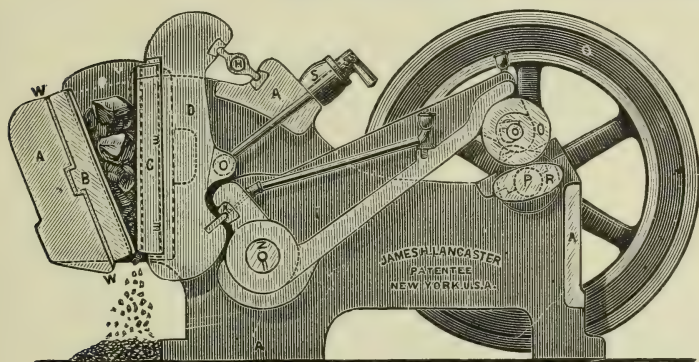
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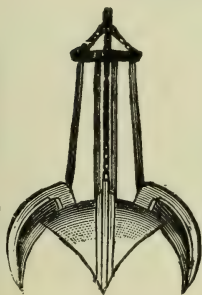
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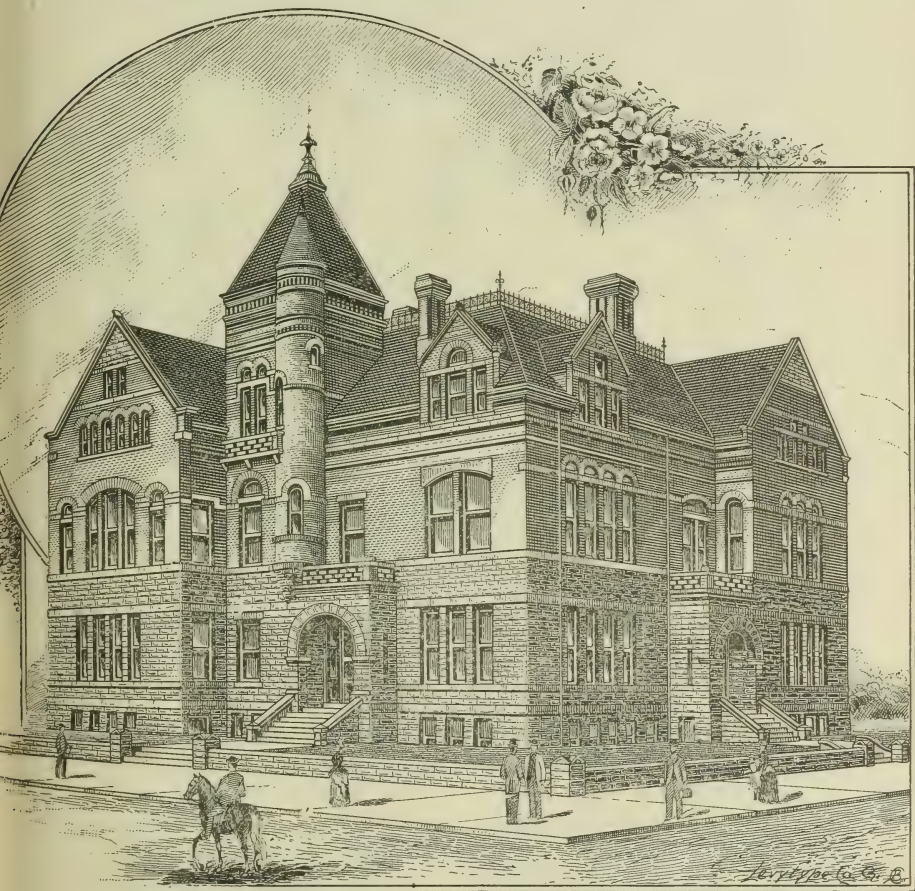
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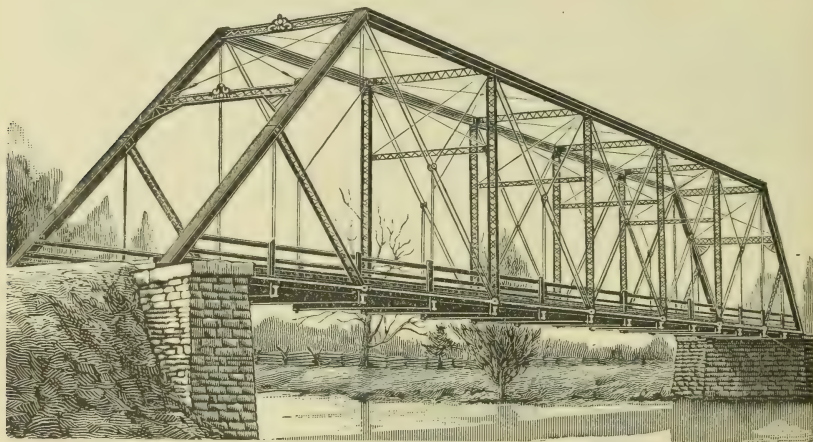
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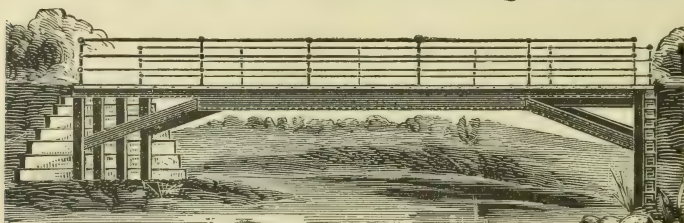
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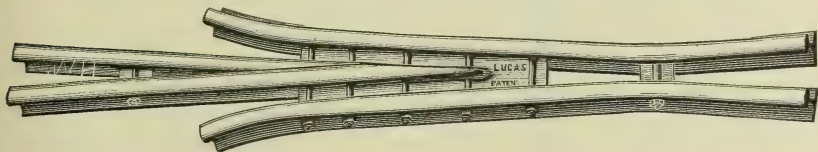
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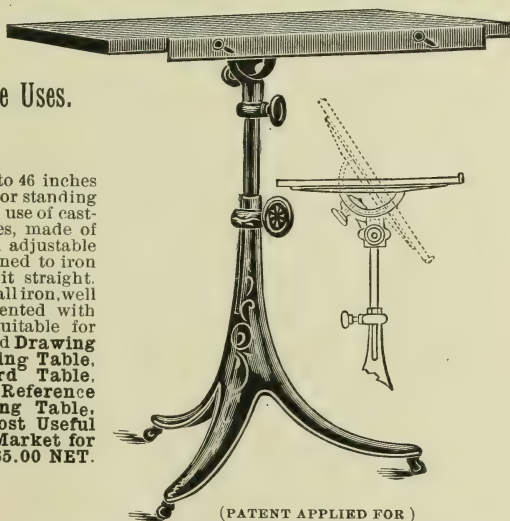
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4. The duty of the first engine of this type at Saratoga, on contract test, was 112,899,983 foot-pounds per 100 pounds of coal consumed.
5. The average duty of above engine in current service from 1884 to 1889, inclusive, six years, was 105,910,739 foot-pounds from coal actually consumed.
6. During the above interval of six years the cost of repairs was less than \$100, as certified by officials in charge.
7. Another engine of the same type, of 80,000,000 gallons daily capacity, was constructed for Saratoga Springs, and tested and accepted in October, 1889. The duty obtained, as reported by Prof. Greene, of Troy, N. Y., was 113,378,479 foot-pounds from coal consumed, and 117,936,698 on an evaporation of ten to one.
8. Other engines of the same type, in number about forty, have been tested by some of the most eminent engineers in the United States, all of them developing high duty beyond all former precedent; and at Dayton, O., eclipsing 10,000,000 engines in a duty of 124,782,157 foot-pounds on a ratio of ten to one evaporation.
9. The capacity of these engines manufactured thus far ranges from 1,000,000 to 20,000,000 gallons daily.
10. They are in use in Boston, Philadelphia, Chicago, Buffalo, Washington, Kansas City, Omaha, and other large cities in the United States.
11. The aggregate capacity of these engines, constructed or contracted for to date, is 570,000,000 gallons daily, which, with other types, make a grand total of 389 engines and 1,167,000,000 gallons, with an average of 3,000,000.
12. In symmetry of proportion, weight, strength, economy, durability, price, comparison is challenged with any other engine manufactured in this or any other country.
13. An illustrated pamphlet of about 300 pages has recently been issued, giving full history of the above phenomenal pumping engine, with full reports of duty tests in detail as made by about thirty mechanical experts, eminent in their profession, which will be mailed upon application to all who are interested in, or may have occasion to purchase, pumping engines. The book demonstrates, beyond all dispute, that the Gaskill compound crank and fly-wheel pumping engines, manufactured under patents by the Holly Mfg. Co., far surpass any other engine manufactured in the world.

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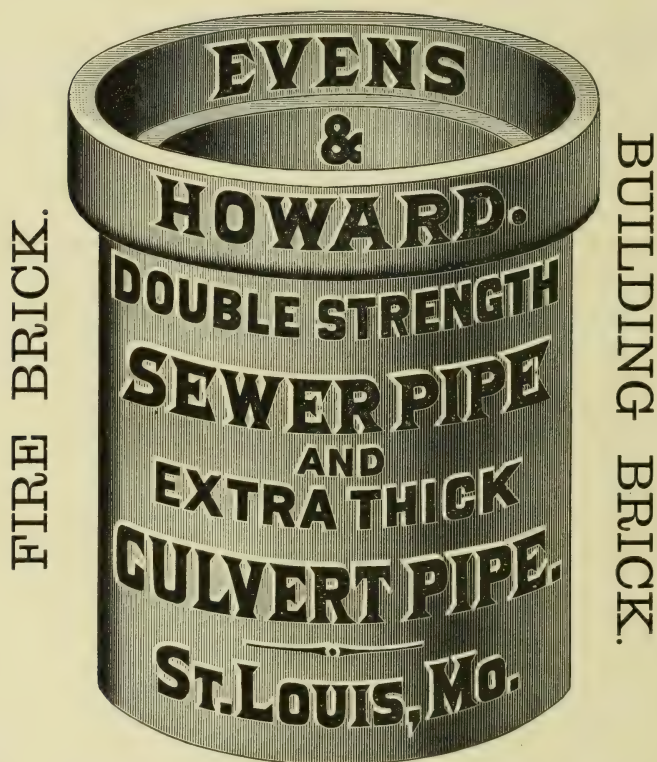
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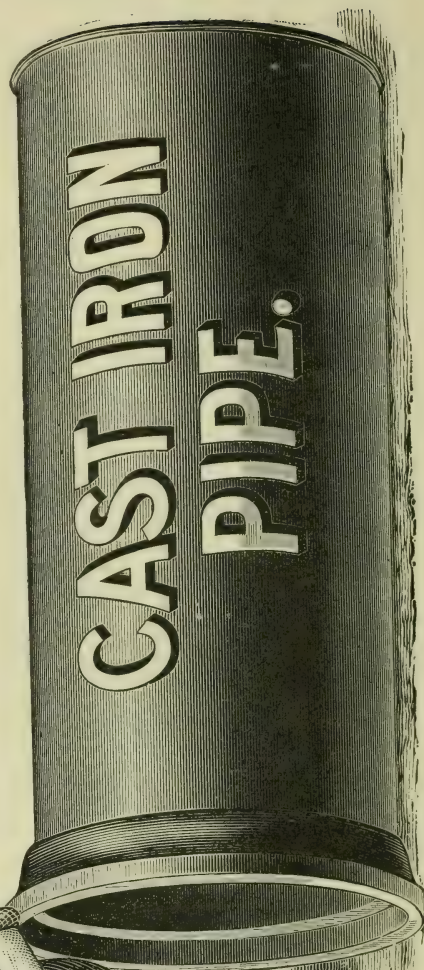
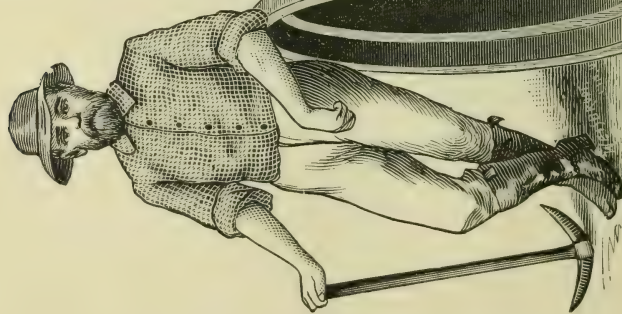
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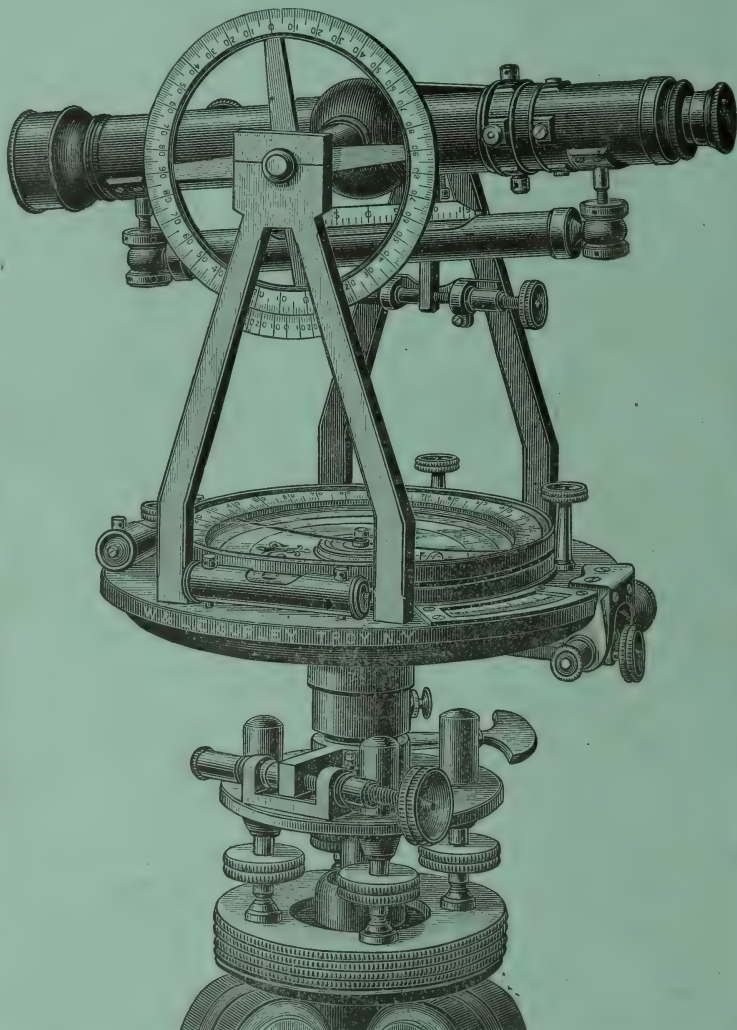
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HELD AT

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THE INDIANA ENGINEERING SOCIETY as a body, is not to be held accountable for any *heretical* or opinionated statements advanced in any of the papers published in this report; but since the object of the Society is for professional advancement, and since progress and development lie outside of the *old ruts*, in the open field—the field of investigation and experiment—the Society says to each one of its members, “Stand up and speak your piece, for the successful men in opening up new highways are the outspoken ones, who look with contempt upon the *beaten paths*,” provided better paths are attainable.

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Summary of Proceedings.

TUESDAY, January 24, 1893, 3:00 P. M.

The Indiana Engineering Society met in annual session in the City Council Chambers, in South Bend, Indiana, at 3:00 o'clock P. M., Tuesday, January 24, 1893, President Phillips in the chair. In the absence of the Secretary, E. B. Vawter, Corresponding Secretary, acted as Secretary *Pro-tempore*. Roll call showed the presence of nineteen members.

Mayor Leeper, of South Bend, was introduced by President Phillips, and cordially welcomed the members of the Society to South Bend, in an address which is given in full elsewhere, and President Phillips responded to the address on behalf of the Society.

The report of the Committee on Legislation was presented by Wm. M. Whitten, Chairman, and referred to the Printing Committee.

The report of the Committee on Engineering and Surveying was read by M. J. McCue, Chairman of the committee. The report was adopted and a vote of commendation given the committee.

E. B. Vawter presented the report of the Committee on Instruments, Blanks and Records, which was adopted.

The Committee on Statistics through L. S. Alter, Chairman, reported and the report was adopted.

The Committee on Printing and Compiling the Reports, made its report which was referred to the Executive Committee for examination.

On motion of Mr. L. S. Alter, a Special Committee on Questions in Practice was appointed by the Chair, consisting of J. R. Brown, H. B. Fatout and W. P. Carmichael. The Society then adjourned till 7:30 P. M.

EVENING SESSION.

TUESDAY, January 24.

Upon assembling in the evening, the Corresponding Secretary presented the resignation of Prof. Jacob Norris, late President of the Society, his duties calling him to a distant field of work in a different profession. Prof. Norris' resignation as a member of the Society was accepted, and the Secretary was directed to notify him of the Society's action.

The Secretary called the attention of the members of the Society to the fact that Mr. Frank Hodgman, Secretary of the Michigan Engineering Society, was present and would like to say a few words relative to the Boundary Line Question, which, by consent, Mr. Hodgman did, informing the Society that the Legislature of Michigan was considering a bill providing for the appointment of a joint commission of the States of Michigan and Indiana, to inquire into and report upon the condition of that boundary and Mr. Hodgman asked the Indiana Engineering Society to take steps looking towards similar action by the Legislature of Indiana.

On motion a committee consisting of Messrs. Carmichael, Vawter and McCue was appointed to make inquiry and suggest action on the question.

The paper by Mr. Frank Hodgman, entitled "The Mountains of Utah," was advanced on the program and presented by Mr. Hodgman.

Society adjourned to meet Wednesday morning at 9 o'clock at the University of Notre Dame.

MORNING SESSION.

WEDNESDAY, January 25.

The Society convened in the Hall of the Society of St. Cecelia at the appointed hour.

Prof. McCue explained to the members present that owing to the unavoidable absence of President Walsh, the

Vice President of the University, Father Morrissy, would supply the place allotted to the President on the program, and Vice President Morrissey accordingly delivered the address of welcome, which was briefly responded to by President Phillips.

The Executive Committee reported the following applications for membership in the Society with the recommendation that they be elected:

Chas. L. Kinney, City Engineer, Elkhart, Ind.; F. W. Keller, Assistant City Engineer, South Bend; Geo. W. Fisher, Surveyor, Crown Point; M. L. Smith, Engineer, La Fayette Bridge Works, LaFayette, Ind.; M. A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute, Terre Haute, Ind.; W. T. Crofts, Assistant Engineer, New Orleans Sewerage Co., New Orleans, La.; Thomas W. Huckstep, Surveyor, Lebanon, Ind.; Wm. E. Graves, Surveyor, South Bend, Ind. The society balloted on the names presented and all were elected to membership.

Mr. W. M. Whitten read a paper entitled "Heterodoxical Methods in Sewer Construction." The paper was criticised and discussed by Messrs. Kinney, L. S. Alter and A. E. Phillips.

Prof. M. J. McCue read an historical and descriptive article on "Hydraulic Cements," which was discussed by Messrs. Whitten, Cheeney, Carmichael and Phillips.

The Secretary read a letter from M. A. Howe, whose name appeared on the program, explaining his absence and submitting a paper on the subject given on the program. A motion was made that the Secretary read the paper which was on "Diagrams of Velocity and Discharge of Water Flowing in Circular and Egg-shaped Conduits," and the motion prevailed. The reading of Mr. Howe's paper was followed by a discussion which was sustained by Messrs. Whitten, Morrison, Phillips and others.

On motion of a member, R. I. Morrison was asked to present his paper entitled "Some Field Notes by an Old Surveyor," and Mr. Morrison complied with the request.

John W. Fawcett's paper entitled "Stadia Measure-

ments," was read by the Secretary, together with a letter from Mr. Fawcett excusing his absence.

The Society then adjourned until 3:00 P. M. The members were entertained in the interim by a sumptuous dinner, and an inspection of the extensive grounds, buildings, apparatus and collections belonging to the University of Notre Dame.

AFTERNOON SESSION.

WEDNESDAY, January 25, 3:00 P. M.

The first paper presented after assembling was a paper by J. F. Meighan, "Notes on Mathematical Tables."

L. S. Alter read an article "Descriptions in Deeds," which evoked a discussion by Messrs, North, Fatout, Whitten, Morrison and Graves.

R. A. Howard presented a paper, "Personality and Realty Before the Courts," which was not on the program, but was substituted for Mr. O'Brien's article on "Coast Surveys." The paper was discussed by various members of the Society.

The subject of "Brick Pavements," which was to have been discussed by E. M. Culp, of Anderson, was passed and A. W. Smith read a paper on "Street Construction," which in a measure dealt with Mr. Culp's subject. Messrs. Morrison, Meighan and others participated in the discussion which followed.

John E. Alter read a satirical paper on "Surveying to Please."

A member presented a series of Resolutions thanking Prof. M. J. McCue and the authorities and students of Notre Dame for courtesies shown the Society, which were adopted without dissension.

A student of Notre Dame, speaking for the students who had attended the several sessions of the Society, thanked the Society for coming to Notre Dame, and expressed appreciation of papers and discussion. The Society then adjourned till 9 A. M. Thursday.

MORNING SESSION.

THURSDAY, January 26.

Upon assembling at the Council Chamber in South Bend, at 9 A. M., the deferred reports of the Secretary, Treasurer and Corresponding Secretary were presented and referred.

The Special Committee on State Boundary, reported. The report was adopted and ordered printed and the committee discharged.

The Special Committee on Revision of the Constitution reported and after being amended in several particulars the report was adopted and the committee discharged.

A resolution was adopted continuing all present members of the Society, members under the new constitution.

The Secretary was instructed to have 250 copies of the Constitution printed.

The Chair announced the Standing Committees for the ensuing year.

The Society then proceeded to the election of officers with the following result:

President, W. M. Whitten.

Vice President, C. G. H. Goss.

Secretary, W. P. Carmichael.

Executive Committee, E. B. Vawter, H. B. Fatout, J. R. Brown: *ex-officio* members, Wm. M. Whitten, W. P. Carmichael.

On motion of Mr. C. L. Kinney, the Society cancelled the rest of the program and adjourned *sine die*.

REPORT OF SPECIAL COMMITTEE ON CONSTITUTION AS AMENDED AND ADOPTED.

CONSTITUTION.

ARTICLE I.

SECTION 1.—This organization shall be known as the Indiana Engineering Society.

SEC. 2.—The object of the Society shall be the encouragement of professional intercourse between the Engineers and Surveyors of the state, and the advancement of its members in scientific research in the various branches of engineering.

SEC. 3.—Among the means to be employed for the attainment of these ends shall be the annual meetings for the discussion of scientific papers, and matters of scientific interest; the collection of books and papers, maps, plans, etc., and the publication of such portions of the transactions as may be deemed expedient.

ARTICLE II.

SECTION 1.—The membership of this society shall consist of three classes,—Active, Junior and Honorary.

SEC. 2.—A candidate for active membership must be an Engineer, Architect, Surveyor or Scientist, and must have been actively engaged as such for at least five years in a responsible position, but a professional diploma from a school of recognized standing in either department shall be considered equivalent to three years' practice.

SEC. 3.—A candidate for membership in the Junior class must be an Engineer, Surveyor or Architect actively engaged as such. Junior members shall be entitled to all of the privileges of the Society, except voting or holding office, and shall be subject to pay the same membership fees and annual dues as Active members, but shall not be subject to special assessments. The time of membership in the Junior class shall be limited to a period of five years from the date of election to the class. If at the end of that period the Society shall deem a Junior ineligible to full membership, his name shall at once be dropped from the rolls.

SEC. 4.—Honorary members shall be gentlemen of acknowledged pre-eminence in Engineering, Architecture or General Science. They shall be entitled to all the privileges of the Society, except voting or holding office, and shall not be subject to fees or assessments.

ARTICLE III.

SECTION 1.—The officers of the Society shall consist of the President, Vice-President, Secretary, and an Executive Committee of five members,

two of whom shall be the President and Secretary *ex officio*. They shall hold office for one year, or until their successors have been elected as hereinafter provided. They shall be elected by ballot on the last day of each Annual Meeting and shall enter upon the duties of their respective positions as soon as the business of the Annual Session at which they were elected is finished. Vacancies occurring during the year shall be filled for the unexpired term by the Executive Committee.

SEC. 2.—The duties of the officers provided for in the preceding section shall be those usually appertaining to such offices and such as may be prescribed by the By-Laws.

ARTICLE IV.

SECTION 1.—It shall be the duty of the Executive Committee to consider all applications for membership, to consider and recommend plans for promoting the interests of the Society, and generally to transact the business of the Society, under the Constitution and By-Laws, and in accordance with such instructions as may be given them by the Society at its regular meeting.

SEC. 2.—No action of the Executive Committee shall be taken except upon the affirmative vote of two of its members.

All proceedings of the Executive Committee shall be reported to the Society and entered upon its records.

ARTICLE V.

SECTION 1.—In addition to the Annual Meeting provided for in Article 3, other meetings of the Society may be held at such time and place as the Society, on the recommendation of the Executive Committee, may by letter ballot appoint.

SEC. 2.—At the Annual Meeting reports shall be presented :

1. Of the Executive Committee.
2. Report of Secretary.

At the Annual Meetings, also, nominations shall be made of candidates for office for the ensuing year, to be voted upon at the time, or by letter ballot, if one-tenth of the membership be not present.

SEC. 3.—At each Annual Meeting the President shall appoint :

1. Two members to act in conjunction with the Secretary, as a Committee on Printing, whose duty it shall be to compile and publish the Annual Report of the transactions of the Society. They shall include in this report all items in the proceedings of general interest; papers read before the Society (carefully revising when necessary) and such other matter as may seem to them advisable.
2. A Committee of three entitled "Committee on National Works," whose duty it shall be, when requested to do so, to meet and act with similar Committees from other Engineering Societies.
3. The following Committees, whose duty it shall be during the year

collect such facts, figures, information or experiments of interest in their several departments as may be brought to their notice, and make at least one formal report to the Society, at the Annual Meeting following their appointment, viz: Committee on Drainage, Committee on Engineering and Surveying, Committee on Public Highways and Bridges, Committee on Instruments, Blanks and Records, Committee on Statistics, of which the Secretary shall be Chairman, *ex officio*.

ARTICLE VI.

SECTION 1.—This Constitution may be amended at any Annual Meeting by a two-thirds vote of the members present, but shall never be amended so as to be limited to the exclusive use and needs of any branch of Engineering.

BY-LAWS.

SECTION 1.—The regular meetings of the Society shall be held in the month of January of each year at such time and place as may be determined upon by the Executive Committee.

The Executive Committee shall provide a room for the meeting, and the Secretary shall give twenty days' notice of said meeting to the members of the Society. Ten members shall constitute a quorum for the transaction of business at any Annual Meeting; seven members at any called meeting; but when, at any such meeting, a quorum is not present, a smaller number may adjourn to another day and enter such action upon the Records of the Society, notice of which shall immediately be mailed to each member of the Society.

SEC. 2.—Candidates for admission, as members, to this Society, shall be proposed in writing by not less than two members of the Society.

The proposal shall be addressed to the Secretary and shall contain a statement, signed by the candidate, of his age, qualifications for membership in the Society and that he will, if elected to membership, conform to all the requirements of the Society. The proposal must then be referred to the Executive Committee, and if, upon investigation, they shall deem the candidate eligible and worthy of membership, they shall order the question of his admission to be submitted to the Society for balloting. If there be five votes in the negative the candidate shall be rejected and shall not again be voted upon for a space of twelve months after rejection. In case of rejection no record of the action by the Society shall be made. But if the number of votes in the negative is less than five, the candidate shall be declared elected, but he shall not be declared a member until he shall have paid the admission fee and annual dues for the current year. Any failure to pay the admission fee and annual dues within thirty days of receiving

notification of election shall forfeit all rights under said election if the Executive Committee so decide

SEC. 3.—The admission fee shall be five dollars, said amount to accompany the application for membership to be returned if the applicant is rejected. The annual dues shall be five dollars and such assessments as may be levied by the Society to meet its expenses. The annual dues shall be payable within sixty days after the Annual Meeting. Within ten days of the Annual Meeting the Secretary shall provide each member of the Society with a written statement of his indebtedness to the Society; and the failure upon the part of any member to meet his obligations to the Society within the specified time, may, upon the recommendation of the Executive Committee, forfeit all privileges as a member. But before any member is dropped from the rolls for non-payment of dues, he shall be entitled to not less than four weeks' notice, during which time he may discharge his dues and be restored to good standing in the Society. Any member in good standing may withdraw from the Society by sending to the Secretary a written resignation.

SEC. 4.—Upon the written request of five members that for cause stated any member be expelled, the Executive Committee shall consider the matter, and if they deem it proper, shall advise the member that his resignation will be accepted. He shall, however, have the right to demand and receive a copy of the charges against him, and shall have a reasonable time to present a written defense. The Executive Committee shall pass finally upon the matter, and if resignation has not been tendered, or satisfactory defense been made, may by an affirmative vote of two of their number, expell the member, in which case they shall notify him and the Secretary of their action, and his name shall be at once dropped from the list of members.

SEC. 5.—The Secretary in addition to the ordinary duties of such officer, shall be the Secretary of the Executive Committee, and as such, it shall be his duty to forward all applications for membership to the Society, to each of the members of the Executive Committee, for their action. Upon the election to membership of any candidate he shall notify said candidate, and instruct him to forward admission fees and dues, within thirty days of receipt of said notice, to the Secretary; shall collect all admission fees, dues, etc., from the members, giving his receipt therefor. He shall be the custodian of all the Society's funds and pay all bills against the Society, upon the order of the Executive Committee. He shall deposit the moneys and invest the funds of the Society in such a manner as the Executive Committee may direct. Besides his Annual Report to the Society he shall furnish such other information concerning the financial affairs of the Society, as the Executive Committee, at any time, may require

The Executive Committee may make such assessments on the Active members as may be necessary to meet any deficit which may occur in the treasury of the Society, and the collection of assessments shall be made in the same manner as the annual dues are collected.

The Secretary shall receive as compensation for his services, his dues during his term of office, and his necessary traveling and hotel expenses in attending the different meetings of this Society.

The Executive Committee shall prepare a program, and order of business for each meeting, and may adopt such rules and regulations for their own guidance as are not inconsistent with the Constitution and By-Laws, and may hold such meetings as they may deem proper.

SEC. 6.—“Robert's Rules of Order” shall be the parliamentary standard on all points not covered by the Constitution and By-Laws.

SEC. 7.—Amendments to these By-Laws may be proposed at any meeting of the Society. Any amendment which shall receive the majority vote of the members present at the meeting for consideration shall be then submitted to the Society for its approval. In order to pass any proposed amendment a two-thirds vote of the members present shall be required.

ADDRESS OF WELCOME BY MAYOR LEEPER.

Mr. President and Gentlemen of the Indiana Engineering Society:

Through the courtesy of Mr. Whitten, our genial and accomplished city engineer, I was invited to extend greeting to you on this occasion. You will understand, of course, that this compliment was paid me because of the official position I happen for the time being to hold, and not by any means because of any qualifications I was supposed to be able to bring to the task. I might add, by way of apology, that as a matter of fact I have as little desire as I have little fitness for such honors, and always shrink from the tasks they impose when I think I can do so with propriety.

It is to be regretted that this convocation could not have been held at a more favorable season of the year, when we were not buried beneath such an extraordinary depth of snow, so that you might have seen more of our town. Nestled here in the beautiful and productive valley of the St. Joseph, with the even-flowing, even-volumed, crystal-like river across its bosom, like a shimmering silver ribbon, South Bend possesses some features, interests and advantages in which its citizens may, as we think, feel a pardonable pride. I shall not burden you with any attempt at enumerating those inter-

ests and advantages. I notice that in your order of proceedings you have provided for visiting our manufactories and other points of public interest; you will therefore be afforded at least a partial opportunity of seeing for yourselves some of the evidences of culture, thrift, and enterprise upon which we as a city pride ourselves. It is particularly to be regretted that you will not have the opportunity of observing our grand army of well-clad and well-behaved working people as they usually throng our streets on summer evenings, especially on the occasion of our band concerts or other outdoor attractions. We should not indeed imagine that factory life is all a round of holiday. The workman must be worthy of his hire; yet there is certainly little in the scenes mentioned to suggest that prosaic side. Happily, your arrangements, I observe, also contemplate a visit to Notre Dame and St. Marys, those famous educational institutions, which though not within our corporate limits, are yet so near by that we lay claim to them as important adjuncts to our city.

An address of welcome, if I understand its import, has, in this era of peace on earth, good will to man, but an empty, perfunctory office to perform if it does not aim in some way to promote the business in hand. I could hardly be expected to be adequately equipped for such an undertaking under the present circumstances. The world allotted to this profession, though wide, fruitful, and replete with interest, is, I am free to confess, well nigh a *terra incognita* to me; and I confess, moreover, to having experienced much disappointment in my unguided endeavors to find *data* concerning its province and its history. The "Britannica," usually quite full in its treatment of topics, has barely the following information directly in point:

"The different departments into which the profession (Engineering) is now divided do not admit of very strict definition; but it may be mentioned that Civil Engineering includes the design and construction of canals, river navigations, harbors, docks, roads, bridges, railways, lighthouses, water supply, irrigation, sewerage, gas supply, telegraphs," etc.

Of course, as I take it, this department has much in common with surveying, which subject, by the way, is quite elaborately treated in the same work. Elsewhere, I have noticed it stated that Civil Engineering as a specialized vocation dates only from about the middle of the last century. Nevertheless, the pressure of population, the rapid spread of civilization, the marked advances in methods of travel and transportation, the reclamation of lands, and the superior knowledge in hygienic and sanitary science have since vastly multiplied its functions and enlarged the sphere of its practical utility.

The problem of street pavement is one of increasing popular interest. Unquestionably, much of the beauty, comfort, and prosperity of a town or city depends upon its roadways, whether good or otherwise. The use of brick for this purpose is now being widely discussed and seems to be rapidly growing in favor. We have some specimens of this sort of street pavement made of our home material which our city engineer, I doubt not would be pleased to have you inspect were it not for its present concealment beneath the great mantle of snow. We have also, I may state in this connection, along this section of the river, practically inexhaustible deposits of blue clay, from which is manufactured as good a quality of bricks for paving, sewer and building purposes as perhaps can be found anywhere. More than ten millions of these bricks are now annually made of this clay, and yet the industry may be said to be scarcely begun. In close proximity, too, is a deposit of marl of unknown extent; and from these two materials—the clay and the marl—we manufacture a quality of hydraulic cement which Dr. John Collet, probably the ablest geologist the state has ever had, pronounces, in one of his official reports, superior to any of the imported brands.

The design and construction of water works for supplying urban populations with water for domestic use and for fire protection require a high degree of expert knowledge. At least, one is led to this conclusion from the round compensation usually exacted for such services. Our stand-pipe system has given unqualified satisfaction, as a system. The

water supply, flowing fresh, pure, and sparkling from artesian wells, seems to warrant an enduring abundance. But the scope and design for the supply and distribution have grown out of adequacy and adaptation, because of the rapid growth of the city since the design was planned. A large portion of the mains are wooden. These, for the most part, have been in use about 20 years. Opinion here is not altogether in harmony as to whether or not these should at once all be taken out and replaced with the iron. I trust that in the course of your deliberations there may be hints dropped on this subject which will be of special profit to us, as well as of general interest to you.

Sewerage for drainage and sanitary purposes is to the people of a town or city perhaps the most important matter that comes within the province of engineering. If this view be accepted, I may be pardoned if I should dwell somewhat on certain features pertaining to this branch of the profession. I shall not, indeed, presume to enlighten the members of this body by anything I may be able to present. I trust only by this means, in some measure, to turn popular attention in a direction which seems hitherto not to have engaged the interest its importance merits.

To begin with, it seems hardly necessary to say that sewerage facilities should be ample for drainage and for sanitary purposes. But sanitary science is yet in its infancy, and the attempt at systematic public interference in this field has a very brief history. Nuisances injurious to health have, indeed, long been made indictable offenses. Shakpeare's father in 1552, and again in 1558, is recorded as having been fined upon such a charge. But for this record, we should perhaps never have heard of that worthy at all. But until times quite recent, the function of the law began and ended with the punishment of the individual offender. Little, if any, heed was paid to prevention or to cure. Legislation undertaking to deal with the fundamental principles involved in the problem is said to begin in England with the Public Health Act of 1848. In this country, the first statute of the kind was passed by the legislature of the State of New York, in 1866. But once

fairly initiated, statutory regulation in this direction has since shown a marked and increasing activity, everywhere inviting painstaking investigation by scientists in that class of phenomena and invoking the agency of government to compel obedience to such natural laws as are believed to promote health and prevent disease. "An epidemic disease," says a standard authority, "is no longer looked upon as a shower of darts from an angry Apollo. It is known to be the consequence of the neglect of sanitary precautions, and the violation of sanitary laws. Of this intimate nature and causes of infectious and contagious diseases, however, we know nothing for certain. . . . But we do know, for certain, that infection is the ordinary cause of such diseases, and that if infection could be efficiently arrested, sporadic diseases would be of comparatively little moment. We further know that pure air and water are essential conditions of health, while polluted air and water are the forerunners of zymotic disease. Sewer gas may or may not be the cause of typhoid fever and diphtheria, but, if not in itself the cause, it is clearly an excellent vehicle for the poisons of those diseases. It is therefore essential to prevent the escape of sewer gas into our houses." Statistics, in proof of these propositions abound, showing that where sanitary conditions have been measurably observed, some malignant diseases have been almost wholly stamped out, the expectation of life perceptibly increased, and the rate of mortality largely diminished. In order that the benefits derivable from such advanced knowledge of the laws of life may be rendered available, the most approved means for ventilation and for the riddance or prevention of noxious gasses must be adopted. It is essential, it may be affirmed, not only that the sewer mains but also all sewer connections from buildings of whatever kind, should be constructed under skilled direction.

In South Bend we have not as yet reached that desired stage of improved methods. In the first place, our trunk sewers are not adequate to the work assigned them. We have no little trouble from the storm water; and then as for looking to the control of putting in private taps, no steps

whatever have been taken. It would seem to a layman, like myself, that this feature of sanitary engineering might be discussed with some profit by this society of experts.

And now, gentlemen, I shall detain you no longer. Thanking you for the respectful hearing given to my crude and long-drawn out remarks, I, in behalf of our citizens, bid you one and all and earnest, cordial welcome to South Bend, trusting that your sojourn with us may prove as pleasant and profitable to you as I am sure it will be to us.

RESPONSE BY PRESIDENT PHILLIPS.

I am sure the society feel very grateful to the citizens of South Bend for the cordial welcome extended to them and we thank Mayor Leeper for his address and the citizens for their welcome. I have no doubt that such a welcome will prove an inspiration to the Society and that this meeting will be one of the best, if not the best one, held in the history of the Society.

The definition of civil engineer is, rather, perhaps an old one and the Mayor has brought it up and I would like to say a word upon that. The term civil engineer has been defined as one who could best turn to account those things in nature which are to be use for the benefit of man, and that man who best understands nature and can best turn nature to the benefit of man will be accounted the most successful engineer whether hydraulic, sanitary, mechanical or otherwise. In the last few years, however, the profession has been differentiated and the civil engineering profession has been divided into its specialties whereby we get our mechanical engineers, our naval engineers and architects and our hydraulic and sanitary engineers also. It is perhaps to be regreted that such is the case, but an engineer certainly should have a thorough education, one based upon fundamental principles that will enable him to cope with nature in all her departments.

We will now proceed with the reports of officers and standing committees.

REPORT OF TREASURER.

Gentlemen:

Your treasurer begs leave to report as follows:

RECEIPTS.

From Secretary for advertising.....	\$255.00
“ Sale of Reports.....	4.00
“ Dues and Fees.....	66.00
Total.....	<u>\$325.00</u>

EXPENDITURES.

G. M. Chenny for expenses from 1891	\$ 10.20
J. R. Brown “ “ “ “	31.60
Printing Committee.....	283.20
	<u>\$325.00</u>
Balance on hand.....	

Respectfully submitted,

H. B. FATOUT,

Treasurer.

REPORT OF THE SECRETARY.

Gentlemen of the Indiana Engineering Society:

The report of the Recording Secretary will also embrace the report of the Committee on Compiling and Printing the Annual Report. That committee resolved at the last annual meeting to break the record and have the reports in the hands of the members of the society on May 1st. You all know how well we succeeded in not doing what we had resolved to do. It now remains for the committee to apologize for the delay in getting out the reports, and if possible shift the responsibility for that delay onto somebody else. In some instances the manuscripts were presented immediately after reading, but most of the gentlemen who read papers asked permission to take and revise them. It was our wish to make the publishing of the reports as little expense to the

Society as possible, therefore we endeavored to and succeeded in securing a much larger list of advertisers than was usual, and that took time. Mr. E. B. Vawter attended to the work of soliciting advertisers and it is chiefly owing to his efforts that this department of our work was so successful. Mr. J. R. Brown as a member of the committee attended to the proof-reading, and the work of arranging, revising and correcting the manuscripts was done by the secretary. A contract for printing the report was made with the Baker-Randolph Company, of Indianapolis, the basis of the contract being 1,500 copies, of 150 pages each for \$250.00, and \$1.60 per page for all in addition to the minimum 150 pages. The cost of printing and the contingent expenses of the committee in detail are as follows:

For printing 1,500 copies of 150 pages.....	\$250.00
“ “ 10 pages extra.....	16.00
“ Etching maps.....	34.80
“ Figure work and cuts.....	4.65
“ 1,500 maps of Kankakee river.....	10.50
“ “ “ Momence.....	10.50
“ Expenses of J. R. Brown.....	15.00
“ “ W. P. Carmichael.....	20.00
“ Freight, expressage, etc.....	20.90
“ Stationery and wrapping paper.....	5.65
“ Postal cards for members directory and programs.....	5.25
“ Bill for postage, E. B. Vawter.....	17.50
“ Bill of stenographer, 1892.....	18.00
Total expenditures.....	\$428.75
Received from treasurer.....	283.20

Balance unpaid.....\$145.55

Your secretary would report receipts for the year as follows:

From membership fees.....	\$ 27.00
“ Annual dues.....	39.00
“ Sale of reports.....	4.00
“ Advertising.....	255.00

Total.....\$325.00

Which sum was paid H. B. Fatout, treasurer.

Respectfully submitted,

W. P. CARMICHAEL, *Secretary.*

REPORT OF COMMITTEE ON LEGISLATION.

To the Officers and Members of the Indiana Engineering Society:

GENTLEMEN:—Your Committee on Legislation respectfully submits the following report:

As to the advisability of this society recommending legislation on any subject, there is room for an honest difference of opinion. On some points we are practically agreed, while other points which some members think most important, are regarded by others with indifference, or antagonized. In matters upon which we cannot have substantial agreement it would, of course, be folly to take action. The question is therefore confined to the expediency of doing anything to influence legislation on those points upon which there is a practical unanimity of sentiment. If by merely passing a resolution advising or requesting certain legislation, this society could secure the enactment of the laws recommended, we might be of great benefit, not only to our profession but to the state at large; for, with all due respect to our law makers, there are a number of matters concerning which this society is better able to form correct conclusions, than the legislature which makes the laws. But unfortunately the passage of such a resolution by this society will have little effect without the same is ably and persistently urged on the attention of the law makers, and the advantages to be derived therefrom fully explained, and all objections thereto fully answered. To do this would require that each and every member of the society, and all interested with us should put forth an earnest and united effort, and then we would be almost certain to encounter the situation so graphically described by the *Engineering News*, of January 19th, which is exactly to the point. After referring to the abuses that are inherent in the present method of bridge lettings, the editor says: "We freely recognize the fact that there is little "immediate probability of remedying present evils of this "sort by legislation, for there is no *politics* in bills of this "sort; and engineers and bridge builders, who are alone

“familiar with the facts and able to frame *proper legislation*
“upon it, cannot do so without being accused of furthering
“their own interests, an accusation fatal to the success of any
“measure which has neither *politics* or *plunder* behind it.”

We most cordially endorse this editorial but do not assert that politics or plunder will in *all* cases insure the success of a given measure, for unless the politics is that approved by the dominant party it is worse than useless, and even *plunder* is not always successful with legislatures, but it is nevertheless true that in advocating any measure with which engineers or surveyors have any connection, we may expect to encounter the *petifoging peanut politician* with large cheek and lungs, little brains, a smattering of the law and little if any principle, whose only ideas concerning engineers or their work has been gathered from contact with other members of his (the petifoging peanut politicians,) tribe whose names have been tacked on to the tail of some county ticket to fill it out, and at the same time reward some party service, and have thus become full fledged county surveyors (?). Their only qualification being a certificate that they have received the highest number of votes for the office, and their only object apparently being to secure plunder, equal in amount to from ten to twenty per cent. of the amount of plunder that other county officers usually *take* without protest from the aforesaid petifoging peanut politician. It is this class of engineers (?) and surveyors (?) by no means as numerous as might be supposed from the attention they have received, whose efforts (for fifteen hundred days in the year) to make water run up hill in open ditches, we hear so much about whenever an engineer is spoken of in the presence of our friend the petifoging peanut politician.

The instinct of the said petifoging peanut politician leads him to seek election to the legislature where he votes himself \$8.00 per day (for services dear at any price) for seven days in a week and mileage, etc., etc. He receives passes on all railways with the implied promise to return the favor. While watching for an opportunity to repay the railways for the passes, he is ready at a moment's notice to set up a howl

if any legislation is proposed affecting engineers or surveyors.

In this howl he is assisted by another variety of his species, namely, the demigoge, who pretends to carry the votes of a large class of the voters of the state in his pocket; said demagogue *fiercely* oppose all *class legislation* and consequently favors any proposition that will compel all other classes of the community to serve *his* particular class at less than half the price like services cost the *ordinary* citizen.

He is therefore ready to insist that the engineer that may be employed on public work in which his class have any interest should be required to furnish his own instruments and conveyance, pay one or two dollars per day for board of himself and team, and work from 10 to 15 hours per day for \$2.50 or \$3.00.

It would doubtless be unfair, however, to judge the entire legislature by the members above described, as unfair, perhaps, as to judge all the engineers and surveyors of the state by the actions of the few so-called engineers (?) above referred to. The fact, undoubtedly, is that the great majority of the legislature, in non-partisan matters, sincerely desire to enact just and equitable laws; but it is also true that a few of the members above described, by unblushing self-assertion and cheek, make up to some extent for what they lack in number and brains, and therefore have more influence than many other members of much greater worth and ability.

In view of the fact, therefore, that in recommending any measure to the attention of the Legislature, no matter how meritorious the same may be, our motives are almost sure to be misconstrued it would seem advisable that we as a Society take no action on the subject of legislation.

One knotty question with which the present Legislature has to deal, namely, the Road Question, is of considerable interest to engineers, first, because as a class they know more about it than any other, and secondly, if there is to be any marked improvement in the manner of road making there will be an increased call for the services of engineers. For while in some localities the services of the engineer may not be

absolutely necessary to secure good roads, in other places failure is almost sure to result from an attempt at permanent road improvement without engineering skill. Not the skill of the *peanut political* engineer (?) above referred to, (which is dear at any price), but such engineering skill as the prudent man employs in private enterprises and which receives a fair compensation for intelligent services actually rendered. The proposition sometimes made that engineers be appointed road superintendents might work well in some instances, but it must be borne in mind that the road superintendent must possess a high degree of executive ability and that some very efficient engineers may lack this faculty. If, however, the employment of an engineer were left to the discretion of a competent superintendent, thus introducing the element of local option in the matter of the use of engineering skill on the highways, then the localities that are opposed to paying the engineer would be free to do the best they could without him, while the more progressive communities could have his services if they so desired it. Then if the engineers employed were worthy of the name, their work would demonstrate that their employers were the *true economists* in road making.

But whatever is done or left undone, one thing is very certain and that is that engineers can much better afford to be unemployed on the roads, than the public can afford that the roads be worked without the advice and skill of engineers.

As to the probability of the present Legislature making such improvement in the road laws as will *keep* Indiana where she now is, at the front, (at least of Western States,) in the matter of highways, there is reason to fear that the very fact that we are now at the front is a serious menace to our maintaining that position. Under the present gravel road laws, many communities having material for road making accessible have greatly improved their highways.

The burden of such improvement has been borne almost entirely by the owners of adjoining lands, while the benefits were shared by the cities and towns, and in fact, by the entire County and State. It would undoubtedly have been more

equitable to have taxed the cost on *all* in proportion to the benefits derived.

Now these communities that were so fortunate as to have material for road making accessible, and have made use of it to a considerable extent, fear that any change in the statutes which will make assessments for future improvements more equitable, may effect them in their general tax, and therefore, they join with the non-progressive element of all other sections in demanding that we be confined to the *old ruts*, not only concerning the gravel road laws, but also the general road laws. If these forces control the Legislature, we may expect to see our sister States, that are now behind us in the matter of roads, but who are not fettered with this unusual combination, profit by our mistakes, and enact laws that will be in advance of ours, both as to equity in assessments as well as character of improvements, and enable them in a very few years to outstrip us in the matter of good roads.

W. M. WHITTEN,

Ch. Com. on Legislature.

REPORT OF COMMITTEE ON DRAINAGE.

To the Officers and Members of the Indiana Engineering Society:

GENTLEMEN:—Your Committee on Drainage, respectfully submits the following report:

There seems to be a general revival of interest in the subject of drainage, as will doubtless be shown in the report of the Committee on Statistics, the Chairman of which has made an active effort to obtain facts in relation to the amount of drainage heretofore done, as well as that now in progress.

The reaction from the abnormal activity in drainage caused by the Circuit Court Act of 1881, has been so far overcome that it is probable that the amount of work now being done is as great as at any former period, with the possible exception of the period above referred to.

If our drainage laws are to be judged by the number of

Legislative Acts on the subject, that is to say, if quantity, not quality, is to be the criterion, then our drainage laws should be eminently satisfactory. If *quality* be the test, however, there is much room for improvement.

The drainage of the Kankakee marshes, the largest body of swamp land in the State, has made little progress during the past year. One reason, and probably the principal reason, for this is that the public has been led to believe that nothing can be done by way of the improvement of this region until the rock ledge at Momence has been removed. While many of the land owners think that with the work done, as contemplated in the Act of 1889, the river, by the operation of natural laws, will soon make for itself a channel of sufficient capacity to reclaim the marsh, or at least to afford an outlet to lateral drains, and consequently all parties interested seem to be waiting for something to be done by the State Commission appointed to remove this obstruction.

During the year 1892, two unsuccessful efforts were made by the Commission to let a contract for this work to responsible parties. The most serious difficulty at present seems to be that the amount of the appropriation is insufficient to do the work, and the Commission has decided to ask the Legislature for an additional \$25,000, with which they believe they can accomplish certain results which will, perhaps, remove some of the *imaginary* difficulties in the way of the reclamation of the Kankakee swamp lands.

The Chairman of this Committee in a paper read at the last Annual Meeting of the Society, attempted to show the fallacy of the belief so generally entertained that the removal of this ledge is essential to the drainage of the Kankakee lands in this State. After showing that the surface of the water at the ledge, which is six miles west of the State line, would be reduced by the proposed work only about 2.15 feet in low water and 1.34 feet in high water, which in low water would be equivalent to a difference of grade in a ditch extending from the State line to the ledge of about four inches per mile, in other words, the effect of the work proposed would be to increase the fall in such a ditch from 8 to 12 inches per

mile, and that so far as lands above the State line are concerned practically the same depth of drainage could be obtained by increasing the sectional area of the ditch about 20 per cent. He stated his conclusions as follow: It would therefore appear that this rock ledge is by no means the insurmountable obstacle to the drainage of the Kankakee region in Indiana which it is popularly supposed to be.

It may be admitted that the removal of the rock, and also the removal of the artificial dams, are of very great importance to the marsh lands lying immediately above the obstruction; but as the distance from the lands to the obstruction increases, its importance diminishes, so that the *principal* benefits occasioned by the removal would be to the lands lying west of the State line. Notwithstanding this fact, however, the benefits to Indiana lands would fully justify the expenditure of the amount proposed in the removal of the rock if the artificial dams can also be taken out. But if this *can not* be done there is no reason for discouragement at the prospect for accomplishing the *complete reclamation* of the *Indiana lands*.

The paper referred to has received more notice by Engineering and Drainage Journals than the writer had anticipated, but so far as he is aware no reasons have been advanced to show that his conclusions regarding this rock ledge were not well founded; but on the contrary his views have been confirmed by a number of engineers who are in position and well qualified to form correct conclusions.

The method of reclaiming these lands proposed in the paper has not, however, received the universal assent accorded to the proposition in regard to the importance of the removal of the ledge. Prof. Campbell, in his remarks on the paper, suggests the only tangible objection to the plan. He says: "Mr. Whitten's proposition for dikes is worthy of most careful consideration. Whether these dikes in the sandy or porous soil along the Kankakee could be made effective is the question to be first determined. If this can be successfully accomplished so that subterranean inlets from the river to the marsh can be closed, I do not doubt that the plan proposed would be feasi-

ble." During the past summer the question raised by Prof. Campbell has been fully answered by actual test. The dikes constructed by Mr. Clark and described by him to this Society at its last meeting, have been found to be effective in the "soil along the Kankakee," having successfully closed the "subterranean inlets from the river to the marsh," and that, too, during a session of extraordinary rainfall.

But as a report of a committee is probably not a proper place for a discussion of a particular problem, your Chairman will only add that after hearing and reading all the comments on the subject of Kankakee drainage that have been accessible to him during the past year, he is more thoroughly convinced than ever that the removal of the Momence rock, while it may be desirable, is certainly not essential to the reclamation of the Kankakee lands in this State; and further, that the cost of straightening the Lower Kankakee by means of a channel of sufficient capacity to reclaim the lands will exceed the benefits to lands affected. That when that section is reclaimed dikes will form an important factor in the plan for the improvement. That such dikes can easily be made effective, that by their use the work can be done at a very moderate cost for construction as well as for maintenance as compared with any other method, and that by their use the work can certainly be made *complete* while without them it will be doubtful.

The excessive rainfall of the past season has given an unusual impetus to tile drainage, and in this respect, if in no other, it has been beneficial. It has also demonstrated that it is bad policy to underestimate the capacity for either tile or open drains. In many instances this has caused great loss to owners of land depending on drains of insufficient size to do the work required of them.

The season has also shown conclusively that the very general idea that drained swamps will do well in dry seasons, but cannot be depended on in wet seasons, is erroneous. Numerous instances have come to the knowledge of the Chairman of this Committee where good crops have been secured on marshes which only a few years ago were considered worth-

less, while on adjoining high priced lands, crops were greatly injured or totally destroyed by the excessive rainfall.

W. M. WHITTEN,

Ch. Com. on Drainage.

REPORT OF COMMITTEE ON ENGINEERING AND SURVEYING.

To the President and Members of the Society:

Your Committee on Engineering and Surveying to whom has been assigned the duty of preparing a report, do not anticipate that the facts mentioned in the communication herewith submitted, are new or unknown to you. However, embodying in this condensed form a few ideas and suggestions relative to the profession and the duties connected therewith, we hope to recall, while here assembled, many incidents that may have escaped the memory, the discussion of which cannot fail to suggest improvements where needed, and the means for advancing the status of our profession. Considering the work accomplished by the civil engineers of the world during the past year, we find that, although nothing of very special moment has been executed or undertaken, yet we learn that much of interest has been done, and in a manner indicating a steady, progressive growth. We also learn that there is a tendency to utilize to the fullest extent the resources at hand and to render them subservient to the best interests of mankind, in this way winning additional honors for a profession, the members of which have done so much to promote the interests of civilization, and to further the progress and prosperity of their fellow men.

The engineering profession is one to which we may well refer with sentiments of pride and admiration. It numbers among its members men whose achievements have won for themselves undying fame; men of great intellectual attainments whose untiring industry and perseverance have taught man how to overcome the obstacles encountered in all great

progressive enterprises, how to bind the distant shores of continents with roads of iron, and to span the rivers with ribs of steel. They have tunneled the mountains, uniting by safe and easy subterranean passages, productive valleys, and affording means of close and rapid communication and interchange between people separated by nature's barriers. They have connected, by means of artificial channels, navigable waters, thus affording opportunities for the commercial world to develop the vast natural resources of continents which otherwise would remain quite useless to man. They have aided in preventing the spread of pestilence and development of disease germs in our crowded cities, thus rendering them the healthy abodes of millions living in those closely connected relations necessary for the prosecution of momentous enterprises.

Men whose lives have been spent in the execution of works of so great import, having so direct a bearing upon the progress of civilization, bringing together, as it were, and binding in close relationship, people and nations, uniting them as one grand whole and teaching them the importance of a constant interchange of ideas and customs, enabling them to secure those advantages that have so improved and elevated mankind, as is illustrated in the history of modern nations, men, I repeat, whose duties have been and are now so directed, must soon win for that profession that recognition and consideration that seems now to be reserved entirely for others contributing no greater advantages for the welfare and happiness of mankind. When we reflect for a moment and consider the time and labor expended in acquiring the information necessary to perform the duties pertaining to the engineering profession we feel that the preparation involves as thorough a drill and discipline of the mind as that of most other callings. Why then are conditions so different? The reason evidently is that people do not stop to consider the sources whence lasting benefits are chiefly derived, and not having the same brought to their attention, are frequently indifferent in their support of undertakings, suggested by engineers for certain improvements, manifestly

for the advantage and prosperity of the community. Engineers must make an effort to remove this want of interest and endeavor to show by every honorable means at their disposal that their great and primary object is to improve the condition of their fellow men; and by honest and faithful service, adopting rigorous measures to drive from their ranks ignorant pretenders, they will soon gain that approval and confidence so freely granted to members of other professions whose labors are considered indispensable, although conferring no greater benefits. Much is being done even now in this direction; a marked tendency to promote the interests and standing of the profession is rapidly manifesting itself. This is evident from the very favorable reports received concerning the excellence of the work done during the past year. Your committee for this reason thought proper to enumerate in this report a few of the most important engineering projects proposed or undertaken, that cannot fail to be of interest to each of us, giving a resume of the most prominent features connected with each, by which it will be seen that although excepting a few noted examples, nothing of very special importance has been advanced, yet our professional brothers in different parts of the world have not been idle, but have done much worthy of commendation.

We will first refer to a subject now attracting much well deserved attention in various parts of our country in consequence, largely, of the noble efforts of the engineer. We allude to the deplorable condition of our public roads, a condition due mainly to the mismanagement and inexperience of those now having charge of their construction and maintenance. No fact was ever more certain than that the present arrangement of our road management must be radically and entirely changed if we are to have the much desired improvements so essential to the best interests of every community. The experience of European countries teaches us that good roads will never be assured while the administration of affairs pertaining to them is assigned to merely local authorities. The supervision must be, as far as circumstances will permit, granted to our state and national governments, which must

be empowered to employ in road construction only persons qualified for the execution of plans founded on scientific principles and the wants of the people who use the roads. In this way only can anything like a uniform and progressive system be inaugurated. Either directly or indirectly the roads are used by all the people and consequently the cost of improving them should be provided for by a general tax. In this way the burden would be more equitably distributed and cheerfully acquiesced in when people become convinced that a judicious expenditure of money is assured.

According to the present system in use quite generally, we see large sums of money annually collected by taxation and expended in so injudicious a manner that little or no benefit is derived. People residing in rural districts, although directly benefited by any change improving the system now in practice, will not, from present indications, be foremost in advocating a revision of the existing arrangement. They could not, even if they had the time, means, and inclination, make those improvements requisite for good and permanent roads, as they lack the engineering knowledge and skill necessary for such work; and judging without evidence or reason, that the expenses would be greatly increased for which burden they alone must provide, notwithstanding the fact that the money as now expended is practically wasted, they are reluctant to adopt, to them untried and new methods pertaining to road management. We find in some sections that there is a marked tendency to resent suggestions made by the engineer advocating changes that, if adopted, would be productive of good results, and imputing to those whose public and enterprising spirit prompt them to make these commendable efforts, unworthy and selfish motives. The engineer, indignant because of such criticism, is disposed frequently to discontinue devising plans for improvement. He knows, as all intelligent men know, that when any method of human action is found defective, and a revision or an entire abandonment of the old established customs becomes necessary, and a new order of things introduced so that the best and most progressive course may be followed, that the only safe and

reliable rule governing the actions of men in such emergencies, is the council of those whose training and experience qualify them to outline and devise means for the purpose of attaining more successful and satisfactory results. Why is it that the engineer when he attempts a solution of this vexed problem is vilified and accused of working for his own personal interests? His motives are evidently misunderstood. The engineer is interested in whatever contributes to the progress and prosperity of the country and community in which he resides. He is benefitted to the same extent as any other citizen whose interests are either directly or indirectly promoted in consequence of discarding bad customs for good ones. In like manner does he share in the reverses resulting from a public policy that tends to check progress. Should therefore the opposition of men, blind to their own and to the community's best interests, incapable of realizing the advantages of great public enterprises, ignorant of the measures they profess to so fully understand and oppose with such determination, deter the engineer from advocating methods designed to secure common roads creditable to our country and to the age in which we live? We answer most emphatically no. Engineers should use every honorable means to effect this result. Officers and agents of railroad corporations should be induced to lend their influence in this movement and much needed valuable assistance could be secured by their co-operation, as no industry is so directly affected by good or bad roads as the one subject to their management.

It is gratifying to report that in some sections of our country an active interest in road improvement has already been taken and much good promised. The Legislature of New Jersey has taken the lead in this matter and by a recent amendment to the road law the County Boards are empowered to provide for the building of macadamized roads subject to certain regulations. The State will contribute a portion of the cost not exceeding a given sum annually. This will necessitate the services of a competent engineer and good results are confidently expected. The Engineering Society of the south during the past year has done much to arouse

interest in highways, by way of exhibitions of road machinery, etc.; several meetings were held in which papers relating to the subject were read and discussed. In this way a great public benefit was done.

The Iowa State Road Convention in session in Des Moines last September, formed a permanent organization for the purpose of agitating the question of road improvement and of securing modifications of the road law. It appears that all present condemned the old and worthless system of working out road taxes showing that progress has been made in this movement in some parts of the Union.

RAILROADS.

The survey and location of railroads are always attended with features interesting to the engineer. During the year 1892, however, railroad construction in the United States did not much exceed that of 1891 which was considered below the average. No extended lines were proposed or in process of construction; work was confined chiefly to building a few short extensions and connections where deemed necessary. Money was expended on improvements rather than to materially extend the present lines. The demand for railroad equipment was active the entire year, and the rolling stock much increased. The same tendency, in a measure, prevailed in other countries, a few noted exceptions are to be mentioned. In South America we have in process of construction a railroad that will be of inestimable value to the districts through which it will pass. We refer to the Transandine Railroad which, when finished, will be the first trans-continental line in South America. A large and flourishing trade is assured as soon as ready for operation. Engineers consider this a remarkable undertaking on account of the many difficulties encountered and successfully overcome. To locate and construct a railroad across mountains so rugged and elevated as the Andes, demands engineering skill of a high order, and now that the completion of the road is assured we know that another monument is to be added to the long list of mighty achievements that have reflected so much honor on the engineering profession. The road is com-

pleted except thirty or forty miles, about ten of which must be in tunnel. This gives but a faint idea of the difficulties encountered by the engineers in charge.

INTER-CONTINENTAL RAILROAD.

The preliminary survey of what promises to be a great undertaking in railroad building was completed last summer. This is the projected Continental Railroad connecting the Republics of North America with those of Central and South America. The plan is reported as feasible but will not, in all probability, be carried out for some years. The parties to whom the work was assigned state that a practical route has been found that present no greater difficulties than were experienced in building the trans-continental roads of North America. If this be true the near future will see the two continents connected by a continuous railroad line.

THE SIBERIAN RAILROAD.

Another great enterprise now in process of construction, and in quite a different part of the world, is the Great Siberian Railroad which is to connect St. Petersburg with the Pacific Ocean. This line is probably the longest, and in some respects, the most important of any now under construction or even contemplated, in the world. Work began last June on the Western Division which will connect somewhere in Central Siberia with the Eastern Division which starts from the Pacific, work on which began some time ago. In this way it is expected that the completion of the road will be effected at the earliest possible date. Many large rivers have to be crossed necessitating the building of several bridges; and some difficulty will be experienced in building the road through the Baikal Mountains. Special provisions must be made for operating the road in so severe a climate as one experiences in most parts of Siberia. The road will undoubtedly be the means of settling the unoccupied portions of that country and afford great commercial advantages. The engineering problems presented are not specially difficult.

CANALS.

Considerable attention has been given recently by engineers to our water courses and the best means of render-

ing them serviceable to mankind. The improvements consist of the removal of obstructions to navigation and the construction of canals in order that distances between commercial centers may be lessened or that an uninterrupted course may be secured between different points. One of the most important works of this character, not only to the United States, but to the whole commercial world, is the now practically assured

NICARAGUA CANAL,

Upon which considerable work has already been done, and which has received lately from the leading business men and legislators of our country that attention which so grand an enterprise well merits. This canal is being built by an American company chartered by an American Congress. Its course is up the San Juan River, across the Nicaragua Lake and thence descends to the Pacific Ocean. The highest point on this canal is 110 feet above the sea level, which is at Lake Nicaragua. The total length from ocean to ocean is about 169 miles, but only 26 or 27 miles has to be excavated. The San Juan River, Lake Nicaragua and artificial basins are utilized for the rest of the course. The estimated cost by the company's engineers is \$65,000,000. This amount was increased by a board of eminent engineers to an extreme maximum of \$87,000,000. If the extreme cost including interest during construction be placed at \$100,000,000 it will equal the cost of the Suez Canal. The route selected is conceded to be the only practicable one for a canal across the Isthmus. The locks are designed large enough to admit the largest vessels and what is specially to be considered it will, when built, shorten the distance by water between New York and San Francisco 10,000 miles. Should the United States government fail to gain and keep control of so important a water way which now is within its power to secure by guaranteeing the company's bonds, it will be guilty of an act of stupidity deserving the severest censure.

PANAMA CANAL.

The now famous Panama project undergoing investigation designed for the same purpose as the Nicaragua Canal, is

sufficiently well known to us all and needs but little comment here. The world knows by this time the cause of the failure of this stupendous undertaking. Bad management, a reckless and improper expenditure of money have been prevalent since the opening of the work to an extent unparalleled in the history of the world; added to this, in the opinion of the best engineers, a sea level canal through the Isthmus of Panama, as projected by DeLesseps, can never be accomplished, as the physical difficulties encountered both in excavating and in controlling rivers are practically insurmountable. It is to be regretted that so grand an enterprise should have an end so ignoble. If more care had been exercised in selecting the route and the advice of those acquainted with the country through which it was to pass followed, the result might have been different. It teaches the advisability of a careful and judicious selection for the location of great works of this character, and that such precautions have been taken in selecting the Nicaragua route that its successful termination need occasion no anxiety.

THE CAPE COD SHIP CANAL.

The Cape Cod Ship Canal is still unfinished, although started on several occasions it had to be discontinued for want of funds. An effort was recently made to secure aid from the State of Massachusetts but without success. It is a work that will afford many advantages when completed and a company may be formed in the near future that will successfully finish it.

DELAWARE CANAL.

The ship canal between the Delaware and New York Bay proposed by Prof. Haupt promises to be realized before many years. The project now is to enlarge the present Delaware and Raritan canal which passes over about one-half the distance, and then build a new canal from the place where the Raritan ends to the terminal point.

The United States engineers now propose a very important project, favored by many, which consists of building a ship canal 20 and 21 feet deep in the shallows of the connecting waters of the great lakes between Chicago, Duluth and

Buffalo. As now proposed, the work is divided into eight sections and must be started by May 15, 1893, and finished within three seasons consisting each of a period of 200 working days. Congress has limited the cost to \$3,340,000.

DANUBE AND ODER CANAL.

A most important canal is now proposed in Europe to connect the Danube and Oder rivers. As now intended it will leave the Danube near Vienna and pass through lower Austria, Moravia and Silesia to Oderburg. If constructed it will be of great commercial advantage to Vienna, as it will give the people facilities for transporting cheaply the large quantities of coal needed in that city. Other branches will connect with the main one, thus opening up an extensive trade.

BRIDGES.

The designing and locating of bridges are always to the engineer subjects of great interest. A few structures of large dimensions have been proposed during the past year while several of less magnitude have been erected and many others are now in process of construction. The first to which we will refer briefly is the proposed East River bridge connecting the city of New York with Brooklyn and approved by the New York Legislature. The bridge was designed by George B. Cornell and probably will be located one mile further up than the present Brooklyn bridge. It will be of the suspension type, presenting the same general features as the Brooklyn bridge. It is provided that the piers shall be of granite and the top 280 feet above the river. The lower part of the piers for 180 feet above the river will be of masonry and the remaining 100 feet composed of steel. The main span between the piers will be 1,620 feet, or 25 feet longer than that of the Brooklyn bridge. The clear height above high water at the piers will be 120 feet and in the center 130 feet. The bridge will be 106 feet wide, containing four tracks for cars, a road way for teams, and sidewalks. Four cables will be used 19 inches in diameter. Right of way is now being secured and engineers are making the necessary preliminary surveys, bearings, etc.

Another bridge has been proposed across the East River at New York of the cantilever type. It is designed for a railroad bridge exclusively, needed by the Long Island R. R. Co., and is to be located just below the south end of Blackwell's Island. The plans call for a cantilever 3,540 feet long; there will be three spans over the river: one 1,000 feet long over the west channel, one 690 feet long over the reef south of Blackwell's Island and one 1,100 feet long over the east channel. There will be no obstruction to navigation, the bridge having a clear height of 135 feet above high water. The approaches will be quite long and extend at the New York end as far as Thirty-eighth street and Fourth avenue. As the tracks will not be on a level with the streets at this end, the station will be elevated above the ground while on the Long Island end the approaches will descend gradually to the level of the railroad tracks.

MEMPHIS BRIDGE.

The great bridge spanning the Mississippi River at Memphis, and the first below St. Louis, was opened to the public last May. This is a remarkable structure in many respects, designed to connect the Kansas City, Fort Scott & Memphis railroad with its southern extension; but it has also connection with other roads entering Memphis from the east. The entire structure is about three miles long and has one railroad track. The bridge proper is 2,597.1 feet long in five spans. The eastern shore span is 225.8 feet; the main span is 790.4 feet; two river spans 621.1 feet each; the western shore span 338 feet. The main span is the longest truss span in this country and the third longest in the world. The bridge is the cantilever type and is in every feature a work creditable to the genius of the distinguished engineer, G. S. Morrison, who designed and supervised the structure.

BRIDGE OVER THE PECOS RIVER.

This bridge, finished last year, is the third highest bridge in the world, and the highest in the United States by several feet. The structure is 2,180 feet long and 328 feet above the river. It consists of 48 spans, alternately 65 feet and 35 feet long supported on steel towers except a few at the end which

rest on masonry. The center of the bridge over the river consists of one cantilever span 185 feet long. The flooring is 21 feet wide and carries one track and two footways. The bridge was thoroughly tested as the work progressed, and built capable of carrying the heaviest freight trains.

TOWER BRIDGE OF LONDON.

One of the greatest structures of modern times is now in process of erection across the river Thames near the Tower of London. It is stated that probably the same weight and exceptional workmanship have never been crowded into so small a compass as in this bridge. Some 31,000,000 bricks, 70,500 cubic yards of concrete, 19,500 tons of cement, 235,000 cubic feet of granite and other stone and 15,000 tons of iron and steel are to be used in construction. The bridge will consist of three main spans. The center is an opening span 200 feet long for the passage of ships and is on the bascule or lifting type, opening in two leaves and are balanced on the main piers built in the middle of the river. The side spans are 270 feet long; 100 feet above the bridge level is another road way for foot passengers only, who will be taken up by elevators in the towers whenever the bridge below is opened. Thus foot traffic will not be interrupted, but vehicles will be delayed while the draw span is open. From the towers are carried two independent foot bridges. Attached to the bridge will be two steam pumping engines for hydraulic machinery, each 360 horse power; eight large hydraulic engines and four hydraulic elevators for passengers. The bridge will cost \$3,500,000.

TUNNELS.

There are a few projects worthy of mention in this department of engineering, the most important of which is the New Simplon tunnel, now being constructed from Brieg, Switzerland, to Isella in Italy, a distance of 12.4 miles, making it when completed, the longest tunnel in the world. It will require eight or nine years to finish the work.

A new tunnel is now building under the Thames at Kingston, near London, intended to increase the supply of water for some of the suburbs of London. A tunnel is proposed

extending under the North and East rivers from Jersey City to Brooklyn and connecting the Long Island railroad with the Pennsylvania and other roads having terminal stations on the west side of the Hudson.

Many other noteworthy engineering projects could be cited did time permit; but we deem those mentioned sufficient to show the enterprise and activity manifested by the engineers of the world. There is one other subject to which we invite your attention for a moment, namely, the subject of municipal engineering which presents so many complex and intricate problems that await the solution of the engineer, and sooner or later must receive more serious consideration. The present tendency of population to concentration and the rapid growth of our cities raise the questions as to the disposal of sewerage and the construction of sewers; the means for rapid transit through the crowded thoroughfares; the construction of water works and the certain supply of pure water; all these problems must soon be met by the engineer to whom all turn for a successful solution. Various and many have been the experiments tried, some operating successfully, others affording but little relief; extensive projects are suggested and work undertaken intended to correct the existing evils. We have the drainage canal of Chicago, work on which has already begun, designed as a means of disposing of the sewerage of the city and preventing the contamination of the water. We see an effort made to provide for the quick handling of freight and a more rapid means of transportation by elevating the roads. These improvements afford some measure of relief but not enough, and much remains to be done. The engineer has a broad field of labor here, which, if success attends his efforts, will produce a noble reward.

DISCUSSION BY C. G. H. GOSS.

It is well known that, in most parts of Indiana, the county public work is handled in a loose, careless and unbusiness-like manner. It is also well known, at least to all progress-

ive people, that the planning and superintendence of this work properly and legitimately belong to civil engineers.

That they are not intrusted with these duties is due to the fact that, as a rule, county commissioners are not men of wide and varied business experience.

There is certainly fault in a law that permits three farmers, who know nothing whatever about the business, to plan a piece of public work, and then appoint another farmer, who knows even less than they, to superintend its construction.

This very thing is done over and over in our state; the people pay the bills, the contractors thrive and the engineers grow weary in waiting. It requires a long time and much effort for some of these farmer commissioners to figure out why it is that a civil engineer wants six dollars per day for his work when a common farm hand can be hired at fifty cents per day.

Commissioners act in these matters, usually, from a mistaken idea of economy and we cannot, perhaps, censure them unless it be upon the theory, that in this enlightened age, no man has a right to be ignorant.

Our laws ought not to permit any officer to act in any matter of which he has no knowledge whatever.

In the light of our experience in the Indiana Road Congress, it seems that any step in the direction of better system in the administration of public affairs in this state will meet with overwhelming opposition, and we can only recommend that engineers push themselves into this work.

We must persistently demand of county commissioner's that we be recognized and employed in the county public work.

HYDRAULIC CEMENT.

The profession of Civil Engineering is one that comprises an extended field of labor, wherein the results of scientific investigation are applied for the convenience, promotion and happiness of mankind. He who is engaged in the practice

of engineering knows full well the wide range of subjects that are presented for his consideration in the course of his professional career, necessitating a thorough training in the various departments of science. He is called upon not only to design works of quite different character, but also to supervise the construction of the same. Bridges and aqueducts, piers and abutments, foundations, etc., are designed by him and constructed under his supervision; also works for the conveyance of water, either for drainage or water supply; the construction of harbors, sea-coast and river improvements, railroads, canals, and common roads are subject to his supervision, and their location is submitted to his judgment, as his training qualifies him to select the most suitable and, what is frequently desired, the most economical site or route. But his duties do not end here. It is of the utmost importance that he has a knowledge of the properties of the materials that are used in the structures built under his supervision, and the various means adopted to preserve them from destruction, thus prolonging their existence and insuring works of a permanent character, fulfilling the purpose for which they are intended. In this way only can a judicious expenditure of money be expected.

Among the various materials that enter into engineering structures not the least important is that of Hydraulic Cement, the subject of this paper. The use of this building material is daily growing in importance, and its manufacture in our country is now an industry of vast proportions in which thousands of dollars are invested. The properties of this material vary within wide limits, depending upon the process of manufacture, and the constituent elements that enter into its composition. For this reason it is essential that the engineer, whose duty frequently is to select the materials that are to constitute works of different character, have a knowledge of the means by which the component parts and strength of this substance can be ascertained, and know the conditions most suitable for use under different circumstances. I do not wish to imply that the engineer's knowledge of building materials should be confined exclusively to

hydraulic cement; a knowledge of the physical properties of other building materials is even more necessary; but this one should receive its due share of attention. Unfortunately, however, it is frequently neglected, and its selection, use and manipulation are entrusted to workmen who, many times, having little scientific training, cannot make so judicious a choice as one whose attainments qualify him for this work.

History does not tell us the precise time when people manufactured and used successfully hydraulic cement, as it evidently dates from a very early period. The ancient Egyptians, 4,000 years ago, were acquainted with a mixture of earthy materials, which, after preparation, set and hardened under water, and was used by them in the construction of masonry. The Greeks evidently were skilled in preparing cement and understood well its importance and use, which facts are evident from the well preserved condition and great hardness of the mortar found in the ruins of some of their works; and it is a well authenticated fact that the Roman engineers in many instances, before they had achieved that distinction in building science, for which they were afterwards noted, consulted the Greeks concerning the use and properties of cement. The Romans, however, as the greatness and durability of their structures show, must have given the subject careful study and attention, and succeeded finally in advancing the art to its greatest perfection. Soon after entering upon their progressive career, they discovered the properties of a volcanic product called pozzzolana, which was of incalculable value to them in their hydraulic works. This pozzzolana is a ferruginous clay, calcined and baked by volcanic fires and was obtained by the Romans near Mt. Vesuvius. The Romans mixed this with common burned lime, and acquired a cement that is not easily excelled in hardness even at the present day.

For several centuries after the time of the Romans, little progress appears to have been made in the art of preparing cement; we learn this from the writings of authors who have treated the subject of architecture. The first man in modern

times to make a thorough analysis and investigation of the subject was the celebrated civil engineer, John Smeaton, of England, who, having charge of the construction of the Eddystone light-house, and finding the necessity of a cement that would harden promptly under water, began a series of experiments, the result of which showed that limestones, containing a large portion of clay in their composition, yielded, when calcined, a product suitable for the purpose required. This discovery induced others interested in the subject to make a rigid analysis and investigation of the properties and geological positions of calcareous stones, the results of which cannot be overestimated. It was determined that the limestones, which rendered, when calcined, the cements, were composed of carbonate of lime, of magnesia, of silica, of alumina, small quantities of oxides of iron and manganese, together with small quantities of a few other substances not essential for cement, all combined in variable proportions; or as it is sometimes stated, 40 to 60 parts of lime and the remainder clay, taken on a basis of 100. Mineralogists have classified these stones under various names, the most important for our purpose being the argillaceous, magnesian and argillo-magnesian. These are found to yield cements of quite different qualities varying in color, weight, hydraulic energy and in the degree of hardness and time of setting, so that experience aided by chemical tests are the only guides for the engineer and builder in determining the best quality for the purpose intended.

Before speaking of the various hydraulic properties of the above mentioned class of limestones, a few words relative to their geological positions and formations may be of interest. Carbonate of lime is found in nearly all the geological formations; more plentifully, however, in the secondary and tertiary than in the primary ones. The greater number of limestones is of organic origin; many have lost this characteristic feature owing to internal rearrangement and now are crystalline in structure. Those not of organic origin, result from chemical deposition from the waters of the globe and are found in beds of various depths, and sometimes covering wide areas.

Those of organic origin which are, by far, the more numerous, are derived from the remains of living organisms which may have grown where the bed now exists or may have been transported from a distance and deposited in the form of a sediment. These deposits vary in thickness from very thin layers up to beds of several feet and extend over large areas.

There are many impurities found in these limestones and it is owing to their presence, particularly the clay and magnesia, that they are valuable for hydraulic purposes, as it is this class that furnishes the cement of commerce. To enter into a full discussion of the various chemical actions and reactions that have taken place and that are now in progress, by which the limestones of the globe were formed would prolong this paper beyond reasonable limits, thus infringing upon your valuable time to an extent that would demand more than ordinary patience. Suffice it to say that the union of the various elements found on the globe under suitable conditions which are known to exist, forms compounds which in turn are acted upon by solvents or by forces that grind them to dust, and then are carried by winds or running waters to other localities where they meet and unite with elements or compounds of a different nature, or are still further dissolved by the water and reunite with chemicals held in suspension, and finally are precipitated by the evaporation of the water or are taken up by living organisms to be finally deposited in vast beds. The chief agent at work modifying the surface of the earth and changing the composition of its rocks, is water. Considering it first in the form of rain it acts both chemically and mechanically to change the general features of the globe. When it ascends into the air in the form of vapor it is considered nearly chemically pure; but after condensation takes place, and it falls to the ground, examination reveals the fact that it has absorbed a small quantity of air which contains carbonic acid, in addition to other ingredients, thus enabling it to act chemically upon many substances, as soon as it reaches the surface, taking up some of the elements therein found and increasing its quantity of carbonic acid, and also organic matter found largely in decomposing plants, in con-

sequence of which its solvent power is greatly increased, finally making its way over or under the surface, enters the lakes, rivers and seas charged with many impurities. In all probability oxygen, carbonic acid and organic matter are the principal constituents that effect the chemical changes. For example rain water containing carbonic acid acts upon the silicates of lime, potash, soda, and other silicates found in great abundance in rocks, converting them into carbonates and liberating the silica. In this way for instance the decomposition of feldspar is effected. Again much of the water that falls in the form of rain permeates the soil and carries with it, in addition to the other ingredients mentioned, organic acids which are supplied by decayed plants. These acids assist in the decomposition of rocks, and this, if the water has an outlet to the surface again, great quantities of mineral substances are carried with it, and either deposited at once or conveyed to the sea there to continue its work of chemical action. The changes that occur in the rocks beneath the surface may take the form of substances added in solution; or some of their constituents may be dissolved and removed; or the portion dissolved and removed may be replaced by new ingredients and the nature of the rock entirely changed. From this brief and incomplete account of the agency of water in rock formation and transformation, assisted largely by living organisms, heat, winds, atmosphere, and climatic conditions, we are not surprised at finding such a variety of ingredients, mixed in variable proportions in calcareous rocks, in consequence of which, they yield products differing widely in composition and value for building purposes.

I mention these existing conditions for the purpose of emphasizing the fact that it is quite impossible from external qualities alone such as color, texture, taste and fracture to determine whether or not a limestone is one belonging to the cement class. These qualities, nevertheless, assist greatly, especially if the specimen examined is found associated with the clay deposits, or if it belongs to a stratum having the same level and general features as the argillaceous or argello-magnesian rocks. The color of these rocks is usually some

shade of grey or dark greyish blue; if, however, the lime is combined with a pure clay, the color is nearly white. The texture is generally compact, and when broken, the surface of the fracture is even.

Owing to the many contingencies existing and the unreliability of the external appearances of many calcareous rocks, one must have resort to chemical analysis in order to pronounce with any degree of certainty upon their probable hydraulic properties. To do this considerable experience in chemical work is necessary; and as the civil engineer, in active practice, usually neglects this department of knowledge owing to his many other duties, he will find the task a difficult one. Still, with an ordinary elementary knowledge of chemical science, he can easily ascertain at least the quantity of clay and magnesia in a specimen of limestone, and as these are the chief constituents that give hydraulic energy, he will be enabled with a considerable degree of certainty to judge of its properties and to determine the class to which it belongs. To make this test, take a small fragment of the specimen stone to be examined—eight or ten drams will be sufficient—and grind it to a powder; place the powder in a small evaporating dish and pour over it muriatic acid, slightly diluted, until it stops effereſcing. Heat is now applied until the liquid is evaporated and what remains in the dish is in the form of a thin paste. This paste must now be thoroughly mixed with pure water and then filtered; what remains on the filtering paper is heated sufficiently to drive off all moisture; when this is concluded the weight of what remains will be the clay or insoluble matter included in the limestone. The presence of magnesia will be indicated by the manner in which the acid acts; if the quantity is small the acid acts quickly at first and then proceeds more slowly. Lime water should now be added to the filtrate while any precipitation is seen and the precipitate carefully gathered and dried; this portion is the magnesia frequently combined with small portions of iron and manganise. This operation is sufficient and will indicate all that is necessary to be known. If the result of the analysis shows that there is present from thirty to sixty

per cent of clay consisting usually of silica, magnesia and small quantities of iron, manganese and alumina combined in variable proportions, and the remainder carbonate of lime, a good, quick setting cement may be expected from the stone, the value of which depends entirely upon the proper relative proportional parts of the ingredients in the mixture. This fact has been fully attested by the analysis of limestones used for cement purposes both in Europe and in the United States. For example the well known Parker's Cement, sometimes called Roman, and first manufactured by Mr. Parker, of London, in 1796, is made from what is known as septaria nodules of the London clay formation, found in abundance in the Island of Sheppy and consisting of the following ingredients, namely: Carbonate of lime, .69; magnesia, .002; oxide of iron, .037; manganese, .012; Silica, .18; alumina, .066; water, .013. This analysis shows, and the investigations of Vicat prove the same, that without a large percentage of clay in combination with the lime only an inferior quality of cement can be obtained. Vicat found this to be true when magnesia alone was present combined with the lime; and he states in his report that when he mixed pure chalk and magnesia the same product was obtained that the natural limestone yielded, containing the same ingredients. The same was found true with sulphate of lime, sulphuric acid and oxide of iron, showing that these substances if present in large quantities will have the effect of weakening the cement. It may be regarded as settled that the most active agent causing the setting and hardening of cement, is to be found in the clay.

Thus far I have confined my attention to the calcareous stones that yield hydraulic cement when suitably calcined and reduced to a powder by grinding in mills constructed for the purpose, as these stones do not slake like common limestone when immersed in water. I will state here in this connection that the same means and process used in calcining common limestone are applicable in calcining hydraulic limestones, and being so commonly known and understood, I deem it unnecessary to dwell upon this part of the work of manufacturing cement.

The class of limestones known commonly as cement stones is found quite generally distributed over Europe and the United States. The cements which they yield are known by certain specific names usually taken from the locality in which the stones are found. In Europe the several different descriptions, differing slightly in quality, are generally known as Roman. In the United States the same name is sometimes applied, but more frequently the term natural hydraulic cement is used, and is understood to include all the various kinds that are obtained from the natural stone.

There are other means of obtaining hydraulic cement superior in many respects to that furnished by the cement stones and known generally as artificial or Portland Cement. This discovery is due to the researches of Vicat, who, learning the properties of the argillaceous stones and knowing that certain materials as brick-dust and pozzuolana mixed with common lime set and hardened in water, showed that by mixing common lime and unburned clay in proper proportions, and then calcining the mixture, a product possessing the same qualities as the cement stones yielded could be obtained. Others repeated the experiment with complete success using common lime either in a state of carbonate or of hydrate mixed with clay; or instead of lime, chalk when found in abundance, was used. The methods employed were the same that are in use at the present day with some modifications and improvements in the details. The main object to be secured is a thorough mixture of the ingredients after combining them in the right proportions so that the mixture may contain the same proportional parts of lime, silica and alumina as are found in natural stones. To effect this the limestone if found soft like chalk is converted into a pulpy mass by passing it through a rolling mill. It is then mixed with the clay and passed through a pug mill; as it comes from this machine it is moulded into blocks and well dried; after which it is placed in kilns, calcined and finally ground to the condition suitable for use. If the stones cannot be obtained in the soft condition mentioned, they must first be calcined and slaked in the usual manner. What is

known in the commercial world as Portland Cement is an artificial compound of chalk and blue clay of the London Basin, ground together in water to a great degree of fineness, then dried and calcined in a manner similar to that described above. This process and discovery of these materials was made by Joseph Aspdin, of Leeds, England, by whom the name Portland was first given probably on account of its resemblance to the Portland stone found on the Isle of Portland. There is a natural cement also called Portland, not generally known, however, made at Bologne, France. It is burned and ground without the addition of lime or other material, from stones found in that locality. It is stated that it has a greater specific gravity than the English Portland and requires less water when made into a paste than either the Portland or Roman. At the present time engineers and the same is understood in commerce, apply the term Portland to all cements made from artificial compounds, and reserve the terms Roman or natural for the product obtained from the hard cement stones. In England and some parts of the continent pure chalk is the principal source of supply in the manufacture of Portland Cement, as it can be easily and cheaply obtained and mixed with clay.

Another great source of supply is found on the bottom and shores of fresh water lakes, both in Europe and in the United States. This material commonly called marl is mostly carbonate of lime with some clay and silicious sand; sometimes it is composed mostly of fresh water shells or fragments of shells and then the name shell-marl is given the mixture. This last mentioned is specially regarded as valuable, when mixed with clay for producing a very high standard of cement.

On the shores of one of the small lakes near Notre Dame there is a deep and extensive bed of this lacustrine or shell-marl from which is manufactured at South Bend a cement called Portland, not excelled by any in the United States. The process of its manufacture is quite similar to that of other artificial cement, and a short description of the methods used and of the composition of the ingredients will serve to

show how this class of cement, now quite common, is produced. This marl, as stated, is composed largely of fresh water shells; the species of *Thysa* and *Planorbis* are the ones principally represented. The question will naturally arise, whence came these shells and what are the conditions that favored their growth in such large numbers, as it is now certain but few are to be found where, no doubt, at some period of the past they lived and thrived in myriads.

To account for this satisfactorily it will be necessary to consider the conditions that existed on the globe at some of the earlier periods of its geological history. I have already referred to the many changes that occurred and the agents instrumental in modifying the crust of the earth and bringing about the formation of the rocks. Now the conditions necessary for the development of these animals were brought about in consequence of these changes and chemical actions which occurred on the globe at some past period of its geological history. These changes were evidently more pronounced and marked in that period than now, owing to the fact that the elements composing the crust of the earth, constituted as it was, and in so undeveloped a state, were readily acted upon by the agents instrumental in modifying its shape and condition. We learned that the most active principle in this work was water. The depressions in the earth filled with fresh water formed reservoirs, as it were, into which was brought from springs and from the drainage of the surrounding country many chemical elements, washed from the soil or dissolved from the rocks and carried into the basin where, if the current of the outlet was sluggish, deposits would take place from evaporation; or these impurities many times furnished the material for the shells of the lacustrine fauna that flourished in the locality at that period. In this way lime in large quantities was brought by the waters that were the source of supply for the lake near Notre Dame and furnished the chief ingredient for the formation of the shells now found in so great numbers, and extracted by the animal from the water during growth. These shells which are the remains of animals living in the lake at that time and composed mostly

of carbonate of lime, were carried either by the current or by the probable prevailing winds and were deposited on the west and south west shores forming extensive beds of the so-called shell-marl. It must be borne in mind that in all such deposits, the material although largely composed of the remains of living organisms, has much in its composition that is derived from other sources; for example: we find sediment that was undoubtedly washed into the lakes at the time of rains or floods and held in suspension until conditions favored its deposition; also a small portion may have resulted from evaporation of the water, in consequence of which, the heavier particles held in suspension remained and settled at the bottom. The shells vary in size from those scarcely discernible without the aid of a microscope to those measuring about one-half inch in diameter. Many have been ground to small particles, and all are embedded in a whitish clayey substance having a slightly greasy feel when wet; but when dry it crumbles readily in to a fine powder resembling dry hydrate of lime. Analysis of this marl shows that it is composed of the following ingredients:

Calcium oxide, ...	35.64%.
Magnesium oxide, ...	0.94%.
Ferric oxide, ...	0.092%.
Aluminium oxide, ...	0.138%.
Silica, ...	0.498%.
Carbonic acid, ...	29.44%.
Water, ...	30.87%.
Organic matter & loss, . .	2.38%.

This marl extends from two to three hundred feet in some places from the shore of the lake, and varies in depth, averaging about ten feet. The part not covered with water is overgrown with a rich growth of grass, the soil for a depth of about one foot being of a turfy nature. This covering is removed and the marl underneath raised with a steam shovel and thrown into large bins built on the shore; from here it is removed to the cement works where it is shoveled into bins constructed for the purpose, and a small quantity of blue clay, perhaps fifteen or twenty per cent., which amount is

determined by experiment, is put with it in alternate layers. This clay is first thoroughly dried and ground in order that it may be more equally mixed with the marl as it is very essential that an even mechanical distribution of the materials be obtained so that the product may be of uniform value; and further, if the clay and marl forming the mixture are not in the proper portions an inferior grade of cement will be obtained. This part of the process can be determined only by careful analysis of the materials aided greatly by experiments. The clay used in this particular instance, called cement clay, is found beneath a stratum that furnishes a good brick material and, according to the State Geologist's Report, 1880, is carbonic acid gas, 14.5%; silica and insoluble earthy matter, 59.133%; Ferric oxide, 1.923%; Alumina, 1.333%; Magnesia, 4.13%; Lime, 12.208%; Chloride of Potassium and Sodium, 0.478%; Moisture, 0.576%; Organic matter loss by ignition, 4.875%. There relative proportional parts change slightly in different places of the stratum. What the manufacturer aims to secure in these operations is a mixture that will contain the same relative proportional ingredients as the natural cement stones furnish, yielding a high grade of cement. The clay and marl, combined as stated, are now taken to the pug mill where they are thoroughly mixed; as the mixture leaves this mill it is cut into blocks a little larger than the common brick and then transferred to the drying rooms where they remain until the moisture is driven off by artificial heat and the blocks are sufficiently hard to be easily handled. They are now placed in the kiln in alternate layers with coal or coke, the latter being considered superior for calcining purposes. The kiln is fired at the bottom and allowed to burn until the fuel is consumed which process lasts about sixty or seventy hours. After calcination it is of a dark color, extremely hard and comes from the kiln in large irregular masses. When cooled sufficiently for handling it is taken to the grinding mill and reduced to a fine powder; usually it is deposited for a few days in open bins after which it is put into barrels or sacks preparatory for shipment. This is the usual method followed in manufacturing artificial

cement throughout the country. Natural cement differs, of course, in the preparation of the material; but after calcination the process of reducing to a powder is identical.

Prof. S. B. Newbury collected statistics recently showing the extent of this manufacturing industry in our country. He reports that the number of barrels of natural hydraulic cement manufactured in the year 1891 was 7,607,067, valued, \$5,512,153. Number of barrels Portland Cement in same year, 454,813, valued at \$1,067,429, making total number of barrels 8,061,880, valued at \$6,579,582. Compared with previous years this estimate shows a great increase indicating a growing and profitably paying industry. New devices recently introduced for manufacturing this material, a better acquaintance of the ingredients that enter into its composition, and of the uses to which it may be applied in building science, have contributed greatly to this advancement specially noticed in the preparation of the artificial cement known as Portland which, without doubt, is superior to the product obtained from the natural stones, as it possesses greater strength both tensile and compressive. The uses of cement are so numerous and well-known that a repetition of them here would be superfluous. It works exposed to the action of water and frost, in foundations for piers and abutments of bridges and all heavy masonry, works requiring great strength and firmness, in all structures such as these the value of cement is incalculable.

This subject, to many, possesses little of interest; scarcely do they give it a thought, much less serious consideration. Yet when studied in the light of science its apparent insignificance vanishes, its concealed properties are made known. Unimportant as it may seem to the careless observer its great utility is unquestioned, its value to man can never be estimated.

M. J. McCUE.

The Committee on Constitution asked for further time. Granted.

The Chair announces the Committee on State Boundaries

as follows: W. P. Carmichael, E. V. Vawter, and Prof. McCue.

The meeting then adjourned until to-morrow morning, Wednesday, Jan. 25, at 9 o'clock, at Notre Dame, at which time the society met and the following proceedings were had:

AT NOTRE DAME.

Prof. McCue: Owing to the unavoidable absence of the President of the University, the pleasing duty of presenting a few words of greeting to the Society this morning devolves upon our worthy Vice President, and our acting President, Rev. Father Morrisey, whom I now have the pleasure of introducing to you.

Father Morrisey: Mr. Chairman and Gentlemen.—In the absence of Rev. Thomas E. Walsh, President of the University, and as representative of him and of the Faculty of this institution, it gives me great pleasure to welcome to Notre Dame the members of the Indiana Engineering Society.

Notre Dame feels honored and highly privileged in being selected as the place at which one day of your valued time shall be spent, and we hope that our efforts to please and entertain you while guests of the University will show you (in some small degree at least) that we are truly appreciative of the honor. One of the regrets that Father Walsh expressed to me prior to his departure for the South, whither he has been called on official business, was that he would be unable to meet the gentlemen who are here this morning. But rest assured, gentlemen, that his expressed wish to give to you a royal welcome finds expressive echo in the hearts of each and every member of our Faculty. It will be our pleasing duty to show you the workings of the various departments of our institution, particularly of that in which you are interested—the Civil Engineering—a department which, while yet in its infancy, shows signs of a healthy growth. Depending as we do upon our own resources, unaided by any State emoluments, or anything else from exterior sources, we may not have reached that degree of perfection and excellence

which, in the near future, we hope to reach. But I think we may be permitted to state that we have now at Notre Dame the nucleus of a department which we feel sure will grow, and grow rapidly, too, particularly as it is under the direction of one whose name here at Notre Dame is a synonym for zeal and energy, the esteemed director of our Civil Engineering Department, Prof. M. J. McCue.

We are deeply alive to the great strides that are being made in the field of civil engineering, and it shall be the aim of all those engaged with that department to make it compare with any engineering school in the country. Notre Dame shall do all in its power to contribute her quota to the intellectual development of our great state, and that liberal, broad-minded and fearless policy which has characterized her movements in the past shall be carried on by her in the further development of her resources.

Again, gentlemen, I bid you welcome to Notre Dame. I trust that your meetings here will be pleasant, profitable, and your visit to Notre Dame will not be the least pleasant of the recollections that you will bear away with you from your visit to our neighboring and enterprising city of South Bend.

Again, gentlemen, in the name of the Faculty of this institution I bid you welcome to Notre Dame.

The Chairman, Prof. A. E. Phillips: We thank the Rev. Father Morrissey and the Faculty of this institution for their cordial welcome to us, and we regret very much, of course, that the Rev. Father Walsh could not be here with us. We should, all of us have been glad to meet him. We consider it a privilege to be permitted to visit this institution and to examine into its workings. Probably every one of us, in some way or the other, have heard of Notre Dame University, and I consider it a great privilege myself, as I am sure that all of us do, to make this visit, and I hope not only at this time but at some other time that we all of us may be able to meet here again, and to further examine into the workings of the institution, and that when the Engineering Course of the institution is developed as it promises to be in the future, it

will have a technical department which will rank with any in the State.

We certainly have been very cordially entertained both by the citizens of South Bend and now by the Faculty of this institution, and we thank the Faculty very earnestly and cordially for their welcome.

HETERODOXICAL METHODS IN SEWER CONSTRUCTION.

BY WM. M. WHITTEN, SOUTH BEND, IND.

Several weeks ago in consultation with our Corresponding Secretary as to subjects for discussion at this meeting, I asked him to secure a paper on the construction of brick sewers, especially touching on the reasons for the thickness usually recommended in text books.

I suggested the names of several of our members who have given sewerage much attention, whose technical training would enable them to treat the subject as it seems to me it deserves. I was anxious for such a discussion for the reason that, in our city there are over five miles of brick sewers that do not come up to the orthodox standard, for thickness, but so far as I am able to judge, answer every purpose as well as if of greater thickness. If, however, there are good reasons for thicker walls to our sewers, the sooner we know it the better.

The Secretary thought it too late to secure such a paper, but said if I would bring the subject up and state some of the facts he would promise that it would be fully discussed. I will therefore confine myself to a statement of the facts, trusting that the discussion promised will be beneficial to all interested.

The first sewer built within the present limits of the city, was a four foot, single ring, circular sewer, on Washington

street from Lafayette street east. It was 12 to 14 feet deep. It was constructed before the organization of the city and was intended for surface water only. Notwithstanding it is only half the thickness usually thought to be necessary for sewers of its diameter, it has stood for about 30 years and seems good for 100 years more.

The outlet of this sewer was in the west race. As above stated it was originally intended to convey only storm water, but it soon became the outlet for sewerage, not only on the street, but sewers from other streets were connected with it to such an extent that the city was enjoined by the Circuit Court from continuing to use the race as its outlet. It therefore became necessary to cut it off and turn it north on Michigan street.

At the time this was found necessary the sewer had lasted 13 or 14 years and there was nothing to indicate a want of stability, neither was there any perceptible wear on the invert. The City Engineer therefore concluded that if a single ring was sufficient for a 4-foot sewer on Washington street, that the same thickness would answer on Michigan street, and the extension north on Michigan street was accordingly constructed of a single ring. No indication of weakness could be detected in this extension and it retained its shape perfectly. The outlet on Water street from Michigan street to the river was constructed about the same time. It was a 5-foot, double ring, circular sewer, with a grade of 1 foot in 9 feet.

With this steep grade it was expected the invert would wear quite rapidly, judging from the rate at which inverts of London sewers are said to wear under ordinary grades.

Several years elapsed after this outlet was constructed before the Water street sewer was extended west. The invert of the outlet was then examined and found to be as perfect as when newly completed, having no perceptible wear.

The engineer therefore concluded that either on account of a difference in material or the uses to which sewers are subjected, or both combined, the sewers in South Bend would

not wear under ordinary grades as they are said to have done in London, and that a 4-foot sewer, in our soil at least, is sufficiently stable if made of a single ring. He also reasoned that inasmuch as the greatest pressure come on the arch of a sewer the vertical dimensions might be increased without weakening the sewer. Since that time there has been constructed nearly six miles of brick sewers, of a single ring, all of which under the generally accepted rules should have been double ring work. They range in depth from 10 to 23 feet. The greater portion are in good ground, (sand and gravel) but some are in quick sand. More than one half were from 1 to 8 feet below the ground water line. The largest single ring sewer is 48 by 68 inches elliptical, with greatest diameter vertical.

Its invert is 22 feet from surface of street and on an average of 5 feet below ground water line. After eight years this sewer is in perfect condition.

No difficulty has been experienced in the construction of these sewers where ordinary care has been exercised. In one or two instances, through carelessness in drawing the curbing, or want of proper back-filling the arch at the spring lines has been left unsupported, causing a settlement of the crown, but the same thing would have taken place if a double ring had been used, for with the lateral or horizontal thrust of the arch inadequately resisted, the weight of 10 to 16 feet of earth will distort any arch of green brick work. At a conservative estimate three million additional brick would have been required to have made all these sewers double ring. Assuming the cost of these brick laid, including cement, labor, and extra excavation, at \$12 per thousand, the saving in cost of constructing these sewers has been about \$36,000, or about \$6,000 per mile. The question now is: Would these sewers have been worth \$36,000 more than they are now worth if they had been made of two rings instead of one?

Mr. Kinney, of Elkhart—The subject of brick sewers is one to which I have given some thought and attention, and my experience as to the wear of brick sewers depends largely on the quality and kind of brick used and the construction.

Here in South Bend where they have an excellent quality of brick I am of the opinion that a sewer constructed out of South Bend brick would last several hundred years, especially where it is constructed deep in the earth—of sufficient depth to be out of the way of frost and other elements that are destructive to brick and especially where the brick cannot absorb any moisture or be affected by any acids that might be in the sewerage. Under such circumstances I am sure it would last centuries.

Mr. Alter—I think the wear in a sewer is not wear at all; it is a disintegration caused by the acids or chemical destruction of the material going through the sewer. As far as mechanical wear is concerned I do not think that any sewer will wear perceptibly in an ordinary life-time, unless there is an unusual amount of sand and gravel passing through the sewer. The brick here at South Bend seem to be unusually hard, and partially vitrified, and they seem to be proof against any chemical action so far, and hence I see no reason why they should show signs of wear.

The Chairman, Prof. Phillips of Purdue University—I should like to ask Mr. Whitten if he has had occasion to notice whether the sewerage has seeped into the soil from the sewer. I do not think there is any question about the stability of the single ring sewer, but there is a question as to whether the sewerage will not seep through the joints into the soil and thus neutralize the effect of the sewerage system. The surrounding ground would then become thoroughly saturated with the sewerage and they would fail in what they are trying to accomplish.

Mr. Whitten—In quite a number of instances we have dug under single ring sewers in laying deeper sewers and I have looked for indications of seepage but have seen none. I presume the double ring might be made a little more effective against seepage than a single ring but if it were necessary it occurs to me that the same security might be obtained by plastering the invert with cement, but if the object of the double ring be to make the sewer impervious then a double ring would be necessary in small sewers as well

as large, and orthodox authorities admit a single ring in small sewers.

Prof. Phillips—If you covered the interior surface with concrete wouldn't that have the effect of preventing, in some degree at least, the discharging of the sewer? Wouldn't it be apt to collect sewerage along its length, and thus make the sewer simply a pest hole?

Mr. Whitten—Not if properly done. I have observed no tendency to collect anything in sewers.

Prof. Phillips—Are they lined with concrete?

Mr. Whitten—No sir.

Prof. Phillips—They are smooth?

Mr. Whitten—They are as smooth as brick work is usually made.

Mr. Kinney, of Elkhart—When I heard Mr. Whitten's subject announced I was rather anxious to have him touch upon one other part of the subject. I know his ideas to a very great extent upon trapping catchbasins are not orthodox; but he didn't touch upon it as I expected he would from the title of the paper.

Mr. Whitten—Well, to tell the truth, I was a little afraid of that subject just at present, as I expected to have all that I could do to maintain my standing in this society when I made the statement that we have built single ring brick sewers 48 by 68 inches in diameter, and feared that if I should add the further statement that we do not trap our storm-water inlets, I should be adjudged insane; nevertheless such is the fact. My observation leads me to conclude that one ordinary stench-trap, otherwise called catch-basin, will produce more noxious gas than 500 feet of sewer in fair condition, or a half a mile of sewer in good condition, hence we do not use catchbasins. If we did it would probably be necessary to place a trap between the catchbasin and sewer to prevent the foul gases, generated in the former, from contaminating the latter. Our streets being of good width, and curbs usually from 15 to 28 feet from street line, we tried the experiment of conducting the storm water into the sewers without trapping the inlets, believing that these untrapped

inlets would increase the ventilation in the sewers. So far the experiment has been entirely satisfactory. Last summer my friend Kinney, with the Mayor and a committee of the common council, of Elkhart, visited our city for the purpose of investigating brick pavements, etc. While here some of the party expressed doubts as to the propriety of these untrapped inlets. On removing the grate from the first inlet we came to, so that they could get as close as possible to the opening, they acknowledged their inability to detect any odor from the sewer. As a matter of fact there has been less complaint of sewer gas from these untrapped inlets than there formerly was from trapped catchbasins and inlets. If any gas can be detected at the inlets it serves as notice to the city authorities that the sewer needs attention and the average citizen is not slow to give information of the fact, so that these untrapped inlets serve as a safeguard against the continuance of unsanitary conditions in the sewers as well as by the increased ventilation they afford material aid in preventing that condition. Perhaps I ought to say further that the outlet for about 200 feet has a fall of 1 in 9, and that the velocity of the sewerage even at the ordinary flow, produces a very perceptible current of air towards the river, and this may have some influence in producing the above satisfactory results. I have not had time to investigate this feature fully but hope to do so in the future.

THE TIMMONS DRAINAGE LAW.

BY M. A. RADER, MONTICELLO, IND.

Or, "a compilation of mistakes and blunders" would be a very good title for this act of the legislature. But I don't want to start out too severe on this well intended piece of legislation. The intention of this law, or of its authors, was evidently good, but it surely does not meet the approba-

tion of even its originators, and falls far short of the demands of the times. My experience with this piece of legislative blundering may have engendered some prejudice against it, but I shall try to treat it fairly. Like all new laws it will take some time and experimenting to bring about the best results. There is now pending before the house a bill which proposes some very good amendments and it will very likely pass in some form, but I hope it will first be cleared of all theoretical matter and embody only good, practical, common sense law. Why is this law such a bundle of mistakes? I think this, like many other mistakes, is due to the originators being non-practical.

The grammatical construction is very poor, and throughout the entire act it discloses a vague idea of the necessities it purports to meet.

The real author of this bill, (whose name and fame is well known in his district), was a senator. He prevailed upon one J. G. Timmons, a representative from White and Pulaski counties, to introduce it in the lower house, so it bears the illustrious name of Timmons. That the real author had an ax to grind is believed by some to be evident from the way he is working under this great (?) law.

But to get at the subject matter: Sections one and two of this act are very good, but I think there is some room for improvement.

Section three is all important and needs a complete revision. It provides that the county commissioners may find for or against the improvements. This should be left to the viewers.

In the preliminary survey one of the viewers "shall be a competent surveyor or engineer." If the board find in favor of the improvement, they shall direct the said viewers, one of whom was "a competent surveyor and engineer," together with the county surveyor or an engineer appointed by the board to proceed with the regular survey. Now this seems to call for two engineers besides the two viewers. "To be on the safe side," as they expressed it, our commissioners in their first experience with this law reappointed the first three

viewers and the second engineer. Now this is extra expense and surely was not the intention, for the latter part of section three says: "In determining the apportionment of benefits, damages and costs, the engineer shall only act in case the two viewers disagree." Now it is very clear that there should be but one engineer, and he should be the one if possible, who made the preliminary survey, so that he can facilitate the work and get it more exact. In our county heads, what is known as the proposed "Wakarusa Ditch," with a total length of about eighty-eight (88) miles for the main ditch and branches. The preliminary and final surveys were made by two different engineers, and they differ materially in some of the essential points of the improvement. This is another reason why one engineer should do all the work.

And it is required to "mark the intersection of lines and boundaries of lands, township and county lines, etc." Where it is at all practicable I think this should be done, but in some localities it is impossible, as the lines cannot be found without a regular survey of the lines in question. And in such localities, it is impossible to give the "distance in feet through each tract or parcel of land," as required. And I think the profile which is required is superfluous.

In two or three places mention is made of "working sections" but no definition for a working section appears anywhere, and so I generally fix the working sections of a length to satisfy myself.

No provisions are specified by which to allow land owners for the necessary farm crossings and flood gates, so we have always allowed damages to the lands needing such improvements, in the amount necessary to build them. In the report I give the location, description and elevation of all bench marks. I think it not necessary to give the number of water ways as required, but give limit of distance without them. And it is required to file the report within thirty (30) days after completing the survey, which in cases of very long ditches is impossible, unless, as I have done, one leaves some trivial part of the survey uncompleted until the report is partly written up. In adjourning the hearing for any cause,

the commissioners should not be compelled to limit the time to twenty (20) days, but rdjourn from time to time until they get matters adjusted the best they can, even if it does take more than twenty (20) days.

And that is a very poor provision which allows the County Commissioners to go upon the grounds in the capacity of reviewers and attempt to readjust the assessments. Very frequently, in fact generally, the commissioners are not as well qualified to act as ditch viewers as the men they appoint to that work, so why should they attempt to revise the work. And without the additional cost of taking an engineer with them and taking test levels, they are not prepared to know whether or not the assessments made by the viewers are proportionate. I think such work is clearly out of their jurisdiction.

One of the fatal blunders of this act is it makes no provisions for the commissioners to render a judgement establishing the ditch, and consequently no one can tell when the lien attaches for the ditch assessment. There again we are left to guess and make our own law. In selling the work, the subject of "working section" puzzles us again. Prior to the hour of sale I think no one should be allowed to contract for this work. Now some look at this as being one of the blessings afforded the poor farmer by the Timmons Ditch Law, but experience has taught us that it is a great bother, confuses the auditor as to the amount of bonds to be issued, and is little or no saving to the land owners. The bonds above mentioned should be made payable in six or eight years. If allowed to run the twenty year limit, the interest would be too great.

The plan for establishing a ditch in two or more counties is, in many respects a very poor one. Applications for damages and objections to assessments and appeals shall be taken to the circuit court of the county in which the greatest length of the ditch is located. Now it has been held that the circuit court of one county has no power to place liens upon lands in another county. Now it seems but right that all

such objections, applications, appeals, etc, should be made in the county where the land is situated.

Sections 21, 22 and 23 should be stricken out of this act, and one similar to it should be made a law governing the repairs of all public ditches. Provisions should be made for the auditor to raise or lower by per cent, the assessments made by the viewers so as to meet the actual expenses of the ditch, similar to the gravel road law.

Last, but not least, comes the subject of pay. As to the engineer, careful and exact work is required of him, yet his pay is no more than that of his co-workers. The drainage commissioner, whose services in this line are frequently not worth more than half that of the engineer, yet this drainage commissioner should get three dollars per day and the engineer should get four dollars per day. The other viewer, who only gets two dollars, should have three dollars per day. He is usually as able in this line as the drainage commissioner, who is frequently only the political pet of the commissioners who appoint him. The chainmen, stakemen, rodmen, etc., should receive one dollar and a half for each day's services. In our county a gang of men recently working under this law, finished their day's work very late in the day, and when they got into town they found most of the lodging places crowded, so they were directed to a good hotel. After breakfast as they paid their bills, they found they had stopped at a two dollar per day house. The chainmen immediately jumped their job, while the two dollar viewer didn't eat anything for a day or two, so as to make his income meet his expenses. Surely our all-wise solons will allow us enough to pay our board and buy tobacco and cigars. Let us hope for the best.

SOME FIELD-NOTES OF AN OLD SURVEYOR.

It may be remarked, at the outset, that the Field-Notes of an United States Deputy Surveyor, as filed at the close of his season's work, are plain, simple and unpretentious. They would not interest you because they must strictly fol-

low the form handed him at the time he gets his contract, and are very similar to the field-notes any of us would make in the survey of the boundary lines of a ten-acre lot.

A short time previous to my engagement on U. S. lines there was a gushing U. S. Surveyor who had a contract on township lines, and he thought he could improve on the simple phraseology required, by writing copious foot-notes extolling the beauties of the scenery. Possibly, he wished to show that he could not only survey, but also had a talent as a descriptive writer, which he was willing to throw in, without additional cost. Sentences like this: "'Twas here, beneath this sylvan shade, the warrior wooed his dusky maid," were not appreciated in the Surveyor General's office. He soon found out that it was not the place for them and that it made the record unnecessarily cumbrous. He escaped with his life, but was given no chance to reform. The next season he could get no contract and his career as U. S. Deputy Surveyor came to an end. Whether he succeeded afterwards in a new field, as an imaginative writer, I do not know, nor does it matter, for that kind of field-notes is not the kind I thought of giving you. If I could get a copy of his, though, I could furnish you more specimens "which," as Artemus Ward was wont to say, "would be very amoosin'."

It is not official nor imaginative field-notes, then, you shall have, but simply a few descriptive notes of wayside incidents observed by an old surveyor. He was not "old" then, being less than twenty-one years of age—but that was more than a generation ago, and the title fitly applies now.

We were running township lines on the upper Mississippi and I was one of the chainmen—the pin-carrier. Buck, a youth of about my age, was the other chainman and it was his duty to care for the chain, and see that it was always kept properly adjusted as to length, and he had it swung to his belt, when not in use, while I had the quiver of pins swung to mine, with every flag in good (bright red) condition. We together compared the chain every day with the standard chain, (which was used for that purpose only). Buck, then, with his pincers and hammer, would shorten the chain to

the proper length. The pins were of steel, spear-pointed, and were much lighter at the ring-end than at the point. Now it required but a few weeks' practice to make me proficient enough, in throwing them to enable me to stick one (or for that matter, two or three at a single throw) into a board, or a tree, at a distance of 25 or 30 feet, with no little precision.

We used a spring-wagon when moving camp on the prairies, but when running lines in timber, we used two mules with pack saddles.

ADVENTURE WITH A BADGER.

It was on one of these prairie moves, one day, that we saw a badger on top of a gopher-mound, probably half a mile distant, apparently asleep or, at least, lazily basking in the sunlight. It was then that a game was set up on the badger. The wagon and party pursued its way in a straight line, which would bring it, at no time, much closer to the badger than it was when we first saw it. I ran ahead towards it until I was about 100 yards distant, when I could plainly see that its head was towards me and that its own mound was about the same distance, (100 yards) off to one side. I then made a detour, drew three pins from my belt, slipped around behind it and made a rush for it, but it saw me before I could get there, and started for its own home. So did I. It was a close race, but the badger won, or thought it had. It was about half way—we were neck and neck and it running the fastest, when I let fly with the three pins. They all three struck it in the flank, and still it ran as fast as I could. *It was carrying my three pins with it*—so I redoubled my efforts to save them. I barely reached the mound, just as its head and body disappeared in the dark entrance, and grabbed it by the hind feet. It tried to push back and get at me. A push with my foot prevented that, and it couldn't, with all its strength, pull itself in. Then it began to claw the dirt with its fore legs and the dirt flew away so rapidly that in a few moments, there was but a thin rim, at the surface, left and when that broke I would either have to let go and run or, fight and get the worst of it. I wanted some one to help me let go, so that I could save my pins—and in a hurry, too. I

yelled for Joe! Now the boys with the wagon, half a mile away, had seen the whole performance, and Joe, our camp-keeper, was rapidly approaching with his hand-ax. He hurried up with his utmost speed, and was on hand—not one moment too soon. He told me to drag it out, and, in order to not spoil the hide, he would wait until its shoulders appeared and then he would strike. It was done as outlined, *the pins were saved*, and the badger—a very large one—was carried between us, in triumph, to the wagon!

When returning to the settlements, I saw and shot a badger and it fell over, but the dark entrance to its mound was near, and it tumbled in. This happened near the spot we had selected for our camp that evening. With the ridge-pole of the tent we could just reach to where it lay, at the bottom of the hole. As the hole slanted downward at an angle of about 45 degrees, it was easy to dig a perpendicular hole, which would reach the badger. We had it dug out by the time supper was ready. It was very fat. We rendered the fat in the frying-pan and filled a couple of quart cans with the oil, which was taken to the home of Gen. W. J. Neeley, in Dubuque, Iowa, where I saw the oil tested. It made splendid lamp oil. Gen. Neeley was one of the party that rendered the fat into oil.

ADVENTURE WITH BALD EAGLES.

Clear Water Lake, or Big Lake, as it was generally called, was about 6 miles across and had an island of about 25 acres near its center. It was in about the wildest and most uncivilized portion of our work, for not a house, nor a sign of a settlement, could be seen anywhere along its shores. We were running township lines and our line struck the island, so it became necessary to get on the island to carry the line across. On a high point, the crest of the island, was a large basswood tree with a grape vine pending from its limbs to the ground. Near the top of the tree was a very large nest made of sticks, some as big as your arm and as long as your body. It was the nest of a pair of American bald eagles, and it had a young one in it. Buck at once declared his intention of climbing up into the nest; and while we expected

there would be trouble—for what might not a pair of eagles do in defense of their young—we had so much admiration for Buck's bravery, and confidence in his fertility of resources, that we cheered him on, and he was soon up and in the nest. It was of enormous size. It was strong enough to easily bear his weight and he walked around in it as you could walk around in a great big tub. He threw down some of the outside sticks, so large and heavy that it was difficult to imagine how any bird could raise them. There was but one young one in the nest—almost ready to fly. There was a large quantity of half-decayed fish there, nearly a half bushel of which Buck threw out with his foot. The young one threw itself on its back and struck, with its claws, at Buck's legs, but he didn't care for that. He heard the screams of the old ones coming back and that was what engaged his attention just then. He seized a club from the nest, and, like a gladiator, stood erect and waited for the onset. They screamed and swooped down and I think I was never more excited as I looked up at this strange battle in the air. The rapid movements of the birds, the frightful velocity with which they would dash at him, with the loud, ear-splitting cries, made it intensely exciting—but, most of all, the danger (as it appeared) to the brave lad who had dared to face such terrible furies. They came at him, however, one at a time, and never did they come close enough to get a blow from the club. While this was going on the young one floundered around until it lost its balance over the edge of the nest and came tumbling down among us. Its wings saved it, however, and it reached the ground unhurt, and at once threw itself on its back, with talons clutching the air, ready to grasp at anything, and to fight the whole crowd. The old ones did not care for Buck now, nor were we afraid of the old ones. We carried the young one over to our camp on the south shore, fixed it on a perch about fifty feet from the tent, tied it fast with a piece of wire, and saw the old ones come and feed it, without any more demonstrations of hostility. In a few days we turned it loose, as we had a line to run in an aspen thicket where we could not care for it longer.

There were several bald eagles' nests about that lake and many pairs of eagles. Fish hawks too, of the largest size, were numerous. In one of my school books, I remember, was a picture representing a fight between a bald eagle and a fish hawk, (I think it was by the great naturalist, Audubon) in which the eagle pounces upon a fish hawk overladen with fish, makes him drop it, and then snatches it before it touches the water. I had here, at this lake, the best chance in the world to see a similar robbery. I have repeatedly seen eagles soaring, a short distance above the water, while a fish-hawk would make a plunge, catch a large fish, laboriously raise it above the water, and slowly bear it away, while the eagle would look on, unconcerned, and perhaps, in a moment or two afterwards, would himself plunge in and catch a fish. Fish were too numerous there—too easily caught—to make it an object for an eagle to steal one, and he is as good a fisher himself, as any bird, and seems to enjoy the sport. What he might do if he was hungry and was where he couldn't catch fish and was then to see a fish hawk, loaded to the guards, pass under him, I have no means of determining.

Another fiction of my childhood's days was dispelled on this survey: That the song of a swan is sweetest when it dies. I haven't time to quote you what Tennyson or any other poet sings about it, for I have to keep a sharp lookout that these, my field-notes, do not become cumbered with longer reminiscences than you can easily bear, barring such quotations from the poets as the gushing youth I told you of was wont to make. If he had known or seen as many Indian maidens as I have, he would wonder, instead, how any Indian warrior, or anybody else, could woo them at all.

THE NOTE OF THE DYING SWAN.

There are many beautiful lakes in Minnesota—very many more than the maps in general use show. And then, on those prairies, there are mirages sometimes, which show distant lakes and timber, most certainly more than you can find there.

I was sitting on the bank of one of these pretty lakes, writing a letter home, when I heard the cry of a swan and

rushing out with the gun saw a pair of them and shot one at short range. Their feathers are so thick that you can rarely do more than waste your ammunition when you fire at them, and they are so shy that you can but rarely get a shot, but here at last, I will have the chance I so long have desired—for see! he falls! From the way he fell it was easy to see he wasn't dead yet and I might yet hear that beautiful song. His fall was slantwise, toward the water's edge, and I dropped the gun and raced to catch him before he could reach the water and did so just as he reached the ground. I grabbed him with both hands by the neck, and had a foot on one of his wings. Then with mighty strength, came a twist, a squirm, and a flop of the wing which struck me on the shoulder, and landed me flat, a yard away. My shoulder was almost crushed by the blow. The swan had reached the water and quickly swam to the opposite side of the lake, half a mile away. His song, if he had any, was reserved for another time and I failed to hear that beautiful song.

A French trapper, named Beauprey, came into our camp that evening and said that a wounded swan was most dangerous to handle. He had known an Indian up in the Hudson Bay country, who had a blow from the bill of a wounded swan, which put an eye out and nearly killed him. Of course that did not scare me any, but you can count me out when there are any dying swans around. I don't want to hear him or come within reach of him when he's dying. Song or not, I'll let them go, hereafter, and never expect to hear the note of a dying swan.

We had many difficulties to surmount and had many adventures in carrying our line across that Clearwater lake.

We planted a township corner on the north shore. We then had a six-mile line to run, due south, to close onto a standard parallel corner, after which we were to come back to our township corner on the north shore, and run west. Our line south struck the island, (as was heretofore related in the story of the eagles) and it was necessary to reach it. Getting onto the island was attended with difficulties. From the north shore it appeared to be fully twice as far to the

island as from the south side; so it was once determined to move our camp to that side,—having first set up a big target on the north shore which could be seen from the island—to build our raft on the south shore, get over onto the island and there run our base lines for triangulating the distance across, to the north, as well as to the south sides of the lake.

We started to go around on the west side of the lake, came to a chain of lakes that took us to the northwest, and at the end of the first day, had effected a passage across the connecting arms and had reached a point on the west side of the chain, but we were about four miles further north than when we started, and were in a dense aspen thicket besides. Did any of you ever attempt to force your way through an aspen thicket? Grape vines, prickly-ash bushes and a miscellaneous lot of undergrowth were so closely interlaced that progress was slow. By very hard work, however, we reached the southwest corner of the lake and here we came to its inlet, the Clearwater river. We swam the mules across and felled a large tree from the steep bank on the other side. The tallest man in the party could barely keep the provision sacks out of water by placing them, one by one, on his head and so carry them until they could be reached by another man in the tree top, and so all provisions, pack-saddles camp fixtures and tent were safely landed and then we had a splendid supper of fish and pheasants and thought our troubles were nearly over—two days' time had been consumed. There was nice open timber on the south shore and the prospect looked brighter.

Next morning, though somewhat appalled to find that the distance was more than twice as far as it had appeared to be when viewed from the north shore, we built our raft. There was no dry timber to be found, so we cut heavy basswood logs, and built the raft in the water in a place where the shore sloped gently into deep water. It was necessary for four of us to go across—the two chainmen, the axman and the surveyor. The four got on and prepared to push the raft off, but it clung to the bottom. It would float with two men on it but two men could not manage it in the wind which

had meanwhile ruffled the lake. Then we had a consultation. The captain and I went up on a high point of land (about fifty feet above the water and a quarter of a mile distant from our camp) and with our field glass we scanned the lake shores in every direction for some sign of a settler's shanty or a boat. None could be seen. At last we made out a canoe load of Indians coming into the lake from its outlet. There were seven or eight of them and were soon followed by another boat load of seven or eight more. They were about six miles distant but were coming slowly around the east shore and were approaching us while we were not long in making them out to be a war party of Chippewas and we concluded to wait for them. We watched them until they came to a point about three-fourths of a mile distant. There they dragged their boats out of water, turned them bottom upwards, made a fire and commenced preparing supper. We concluded to go over and buy or hire one of their boats and were about to start when, suddenly, an unearthly war-whoop rang in our ears and two painted devils jumped out from concealment in the bushes at our side and brandished their tomahawks over our heads! Then the Indians laid down on the ground, rolled over and over, nearly bursting with laughter, to think how badly they had frightened us. Who says an Indian never laughs? We laughed too, then, but it was a sickly laugh. They had seen us watching them, had slipped away from their party, had ambushed us and, seeing that we were white men and not the Sioux they were looking for, had played on us this trick. They wanted to look through the glasses and were much astonished to see their camp-fellows brought so near. Our captain then began business, but they either couldn't or wouldn't speak a word of English. So we went to their camp with them and had no better success there. Without much difficulty we made out to be understood by signs. They would not sell at any price, and would not hire, as they expected to break camp that night. "Nepo Sioux," said one, and then patted himself on the breast, and held up both hands to show that he alone was going to get ten Sioux scalps.

We went back to our camp and put a guard over our

mules. I was on from midnight until daylight. It was as dark as Egypt. About two o'clock the mules began to snort. I could see nothing and although I knew the Indians were around, I didn't want to wake the boys up needlessly. I had already been scared within an inch of my life, and I did not think they intended to do us any harm, anyway, but I did not know. I put a halter on each mule, laid down as flat as I could get, and knew the Indians couldn't see me any better than I could see them. I kept perfectly still and a slight pull at either halter would assure me the mules were still there. So passed the night. In the morning when Joe, our camp-keeper, went to get out our tin plates and tin coffee cups, at breakfast time, they were gone, and we had to do without, until we sent Buck down to the Clearwater settlement at the mouth of the river, on the Mississippi, to get a boat and a fresh supply of tinware.

He obtained both and poled the boat from the Mississippi, up the Clearwater river and into the lake. We carried our line across the island and lake and found the closing corner a short distance from the south shore.

But while Buck was gone after the boat we had a rest and I went fishing. With a few little green frogs for bait, I got into the felled tree top at the lake inlet. The water was perfectly clear and about ten feet deep under the limb I was on. I saw a pike about two feet long slowly swimming up stream. This was as large a fish as I cared to handle—larger ones were numerous, but, to save my tackle, they were allowed to pass unmolested. My weight had sunk the limb until the water was about up to my waist and I quickly wrapped the line about my wrist and threw the baited hook to the pike. He took it and started for the lake and under I went—then the tree top would spring up again and I could get my breath when another surge of the fish would send me under again. Joe saw it all from the hillside and yelled: "Hold onto him—I'll fix him." By this time my wrist began to pain me, the circulation having been entirely stopped by the tightly drawn line. Joe ran towards the lake, threw in stones and the fish concluded to change direction and try it up stream a while.

This allowed me time to scramble up the tree top to the bank and then the fish was easily landed at leisure. It was the last time, however, that I ever made a fishing rod by wrapping a line around my wrist.

In the latter part of the season, having obtained a contract for the subdivision of six townships, a man was hired to take my place as chainman and I finished the line, of three townships, (186 miles,) before the season's work was closed by the approach of cold weather.

The Sioux Indians were moody and discontented. They were on the eve of an outbreak, which came to a thrilling reality the next summer, (1857,) and resulted in the Spirit Lake massacre, for which many of the Indians were hung. On account of this outbreak no surveying work in Minnesota was done during that summer and I was released from my contract to run the section lines of the remaining three townships. I then went to Kansas in search of work and spent the summer of 1857 in that territory, among the "border ruffians" of Missouri, and the "free state" men. It was about as dangerous as to be among the Indians I had left in Minnesota. Nearly every man you met wore an outside belt, with a Colt's revolver on one side and a bowie knife on the other. I dressed in that style too, because it was the fashion, and I had little trouble, while, if I had not, I might not have fared so well.

I had a pair of very large mules, young and spirited, and for a time, carried passengers between Leavenworth City and Lawrence, 35 miles apart. One day in Lawrence I agreed to take a party of five young Virginia Quakers to Benajah Hiatt's claim, near Russell's Mills, on Stranger creek. As there was no direct road from Lawrence, it was necessary to go on the road towards Leavenworth until the creek was reached and then follow up the creek to the Quaker settlement. A terrific thunder storm came on us just as we were about to emerge from the timber along the creek and to strike out on the roadless prairie for a lone cabin which we had seen before it began to rain, about a mile and a half away in the direction we thought we ought to go. We were driving

rapidly through the tall grass of the creek bottoms, being anxious to reach the cabin before nightfall. Suddenly there was a commotion and an uproar, like the loud flapping of wings, under the mules, and I saw the head of an enormous bird between the mules and above the wagon tongue, while its body was below and its wings were beating the air and the belly of the mules, in the frantic efforts of the bird to get loose. The mules were frantic also, and at the first dash ran away; the five young men tumbled out of the back end of the covered spring wagon, and I sat on the front seat with the greatest difficulty, holding on to the lines with an energy born of despair,—for I could not afford to lose my mules,—if they got away it would be a hopeless task to ever find them again. It was a frightful runaway. A considerable time elapsed—to me, many fearful seconds,—before the bird got loose and flew away, but the mules kept on going for probably a half a mile before they were checked. The bird was as large as a full-grown eagle,—to me it seemed even larger,—and it bothered me that I could not imagine to what specie it belonged. The rain came down in torrents. While the fright was still on the mules, a curve, of radius enough to prevent upsetting, was turned and the course reversed, but by the time I had reached the bedraggled young men, standing shivering hopelessly in the rain, it was growing dark. They had given me up as lost, themselves as well, and expected nothing better than to spend the night cold, wet and cheerless, without shelter, on the desolate prairie.

The explanation of the ornithological question was now easily settled. As soon as they had picked themselves up, after their tumble from the wagon, and had found out that they had no broken bones, they went back to the place where the runaway began, and had found a nest containing nine wild turkey eggs, yet warm and unbroken. One of them quickly put the eggs inside his vest to keep them warm. They were glad enough that I, too, was unhurt. They sprang into the sheltering wagon and then we continued our course for the cabin. There was no friendly light to guide us, and there was danger of passing the house and of losing ourselves on

the prairie, but instead, in due time, the mules ran into a fence, and a call brought a light and a woman to the door. She explained that they used no light unnecessarily—they went to bed soon after dark and needed none. With a quilt over her shoulders to keep off the rain she came outside the fence and started us in the right direction to reach Hiatt's house, a quarter of a mile further on. The house was found as before. Mrs. Hiatt took the turkey eggs, placed them under a setting hen, and was delighted at the prospect of raising a brood of wild turkeys, the eggs for which had been obtained in a manner so unusual.

A few days after the wild turkey incident, during the bustling preparations of the Albert Sidney Johnson expedition to Utah, (which was being fitted out at Fort Leavenworth, to bring Brigham Young under subjection to United States authority), I took my mules out from the city to the Fort, $2\frac{1}{2}$ miles, to sell them. The quarter-master would not pay the price asked; but, while he was looking at them, Gen. W. S. Harney, a tall, grizzled officer, stepped up and said: "Dam-fine pair of mules, Lieutenant; what does the boy ask for them?" His next remark, as he turned away: "Great God! is the boy crazy?" convinced the quarter-master, more than ever, that Uncle Sam did not want them, so I drove them back to the city where, next day, they were sold to a liveryman, at the figure refused at the Fort. (\$175 per mule was Uncle Sam's maximum price at that place and time.)

As I could get no contract on United States lines in Kansas, my field notes, though slightly off of line, are closed.

Many more singular incidents were recorded in those unofficial field-notes of United States lines on the upper Mississippi—too many for entry here, for want of space. In closing, however, it may be remarked that the work on which we were there engaged was attended with the occasional discomforts of exposure to rains and storms—of marshes and streams to wade—of briars, thorns and prickly-ash thickets to tear through—of mosquitoes, both night and day varieties, and ravenous flies and ticks to beat off—and of lack of food and shelter whenever our camp could not be found at the

close of the day's work; but, generally speaking, we enjoyed our pipes after supper, as we sat around the camp-fire and patched our clothes or shoes, ready for the morrow's wear. Though the scenes were ever changing, we were so shut out from news of what was going on in the world, and from any tidings from our far distant-homes, that the time dragged heavily. Each week seemed a month, each month a year, and when a return to civilization came at last, our appreciation of its comforts, was higher than had ever been dreamed of before.

R. I. MORRISON,
Knightstown, Ind.

SURVEYS IN COURT.

Why should the citizen be better protected by the courts in his rights to personal property than in his rights to real estate?

STRAY THOUGHTS ON THE ABOVE QUESTION.

In case personal property is stolen, the owner can take it wherever he can find it, and even have an innocent purchaser arrested and compel him to show how he came by it. But when it comes to land, "presto," the court tumbles over on the side of the rogue and helps him steal land he has no shadow of a title to.

Take the following case: A enters the N. E. quarter of section 8, T. 10, R. 12, E., and B the S. E. quarter of the same section. They are honest, and as they do not know exactly where the section line is they put a fence about a rod or more west of it so as to be sure not to take anything that belonged to others.

Some time after this C and D come along and C enters the N. W. quarter and D the S. W. quarter of section 9, same township and range. They are not like A and B, but in the absence of A and B take some measurements and find that the line between C and D, measuring to the fence on the west, is a little over 161 rods long, and the line between A and B is a little less than 159 rods. They go to A and B and ask if they know where the section line is. A and B reply

that they do not, but intend to have a survey made and have it fixed. C and D ask if they may join their fences up to A's and B's. A and B being unsuspicious and disposed to be neighborly answer that they might for the present. Now C and D do not want a survey, and if they can prevent its being made until the fences have stood a little over 20 years they steal the land. But after the 20 years, then they *must* have a survey. They see the county surveyor and notify A and B that the surveyor will be there on a certain day to run the section line and establish the quarter section corner.

The surveyor being a young man and wishing to post himself as to his duties procures a copy of the statutes of the great State of Indiana. In that he finds, Sec. 5956, "that all division lines which may be run to divide any of the lands sold by the United States shall be made agreeably to the laws of the United States directing the mode of surveying public lands."

Now what is to be done? He has no copy of the U. S. statutes. But, he *must* get ready for that survey which is to come off in a short time. He makes inquiries of some of his lawyer friends and gets a few of the U. S. laws, but not what he wants. Finally he sends to Washington, D. C., making inquiries in regard to the laws governing the mode of surveying the public lands, etc., etc. In a few days one of Uncle Sam's boys brings him a little book, the title page of which reads: "Instructions of the Commissioner of the General Land Office to the Surveyors General of the United States, relative to the Survey of the Public Lands and Private Land Claims." The next thing he finds in it is:

"Department of the Interior, General Land Office,
WASHINGTON, D. C. May 3, 1881.

Gentlemen: The following instructions, including full and minute directions for the executions of surveys in the field, are issued under the authority given me by sections 453, 456, 2398 and 2399, United States Revised Statutes, and must be strictly complied with by yourself and your deputy surveyors.

Very respectfully,

J. A. WILLIAMSON, Commissioner.
To Surveyors General of the United States."

He finds on page 7 that "The act of Congress approved February 11, 1805, directs the subdivision of public lands into quarter sections, and provides that all corners marked in the public surveys shall be established as the proper corners of sections or subdivision of sections, which they were intended to designate, and that corners of half and quarter sections not marked shall be placed as nearly as possible equidistant from those corners which stand on the same line."

Now our young surveyor is ready, and the time which flew so rapidly before he got this information goes at a snail's pace and he impatiently awaits the arrival of the day fixed for that survey.

On the appointed day the surveyor goes onto the ground and each of the interested parties hands him a deed showing their respective rights. He looks over the record (for the deeds have all been recorded) and finds that A owns the N. E. quarter and B the S. E. quarter of section 8, T. 10, R. 12, E., and C owns the N. W. quarter of section 9, and D the S. W. quarter, same township and range. All plain sailing, could not be better. But no witnesses can be found for the quarter section corner. So he follows the law and instructions, finds and identifies the two section corners and runs the section line very carefully, helping to measure it himself and sets a stone, properly marked, on the line, equidistant from the two section corners, takes witness to corner, goes home and makes a record of what he found and what he did, congratulating himself that that survey will never be set aside, for he had tracked the law and did his work too well for anything of that kind to take place.

Now, if A and B do not attempt to move the fences to the line staked out by the surveyor, nearly 36 months may go by when A and B receive notice that an appeal has been taken from that survey. After the case has been continued term after term on some pretext or other for three or four years they finally come to trial. They come into court, C and D prove that the fences have been kept in the same place for more than twenty years, and that they have had peaceable

possession of the land for that length of time. The Court decides against the surveyor. But feeling a little mean, probably, about entering up a judgment so manifestly unjust, will privately tell the surveyor that no doubt his survey was correct and notwithstanding the laws of Indiana, the United States statutes and instructions of the Commissioner of the General Land Office, would bear the surveyor out in what he had done, the Court would have to "decide against the surveyor." That is, the surveyor was wrong and the stone put down for the quarter section corner was not in the right place. The court then appoints S. R. to make a new survey.

But why does the court make a decision so contrary to the laws? Because some "thumbstick judge" some years ago, in order to help out a friend, probably, made such a decision, i. e., set a precedent, and all the little judges must follow suit. They try to make it appear that it is done to settle disputes and end lawsuits. But does it end them?

S. R., Surveyor No. 3, travels the same road (there being no other, the court not being allowed to give any instructions) that Surveyor No. 2 had gone over. He examines the record, (deeds) abstract of title and finds that A, B, C and D each own a quarter section of land having one corner common to all four quarters. He looks up the law, both State and United States, notifies the parties interested that he will be there on a certain day to make the survey. On the day fixed he goes on the ground, runs the line, takes his measurements and finds every thing agreeing, substantially, with the report of Surveyor No. 2.

Now he is in a quandary. He says to himself, "The court decided against Surveyor No. 2, and if I leave the corner where it is, the court will, most likely, decide against me." While thus communing with himself, an old man comes along and says, "Hello! Have you found the corner? I wuz over ter Sam Jones's an' he sed they wuz over hyar servain an' how ther wuz trubble 'bout this corner an' I tho't I'd cum over an' p'r'aps I could give yer a pinter as I used ter be in these parts consid'ble an' kerried ther chane when they fust servayd 'long hyar, but I've bin livin' in Kansas er good

spell an' now ef you've run ther line strait an got ther middle like ol' Hendricks did you've got mity clus onto ther right spot. Hol' on, lemme see. I wuz thinkin' 'bout enterin' thet quarter over thar, wunst, an' we put a stone down hyar fer this corner an' I don't believe it could hev got away, kase it wuz a big un an' down in a low like place an' I'll bet you a chaw tobacker ef you'll dig down thar 'bout three feet you'll find a big nigger'ed with figgers on it thet we put thar more'n sixty year ago.

So the surveyor and his assistants dig down about thirty inches and find a stone, properly marked, nearly directly under the place where the stone was set by Surveyor No. 2, who was called on by C and D some five or six years before. Both stones being properly marked, the surveyor leaves the lower one and places the other immediately over it and now he is all right. Well pleased he goes and makes his report to the court.

A and B set stakes and prepare to move their fences. C and D tell them not to touch the fences or they might get into trouble. A and B being somewhat timid as to law matters, consult together for some time and call on the attorney who talked so eloquently on their side in their first law suit. But he, like the talented young lawyer, who, when the parson asked him to join the church and use his fine talents in the service of the Lord, politely informed him (them) that he was engaged on the other side. This, to A and B was a stumper. How any one could talk as he did on their side and now get over on the other, was a mystery. But they were paying taxes on the land and the other fellows getting good crops off of it, rather went against the grain, and hearing that another lawyer had opened an office in their county town, they go and lay their case before him, having first ascertained that he was not engaged on the other side.

He tells them that they have a good case, but if they will wait a few months their case will be somewhat improved, for the corner will become established in three years after the survey has been made. They wait, but the day before the

three years are up they receive notice that C and D have taken an appeal from the survey made by Surveyor No. 3.

They all come into court and repeat the former trial with the addition of the evidence of Surveyor No. 3, who, in answer to a question by the court, says that he used a sight pole six feet long, octagon shaped and one and a half inches in diameter. But his evidence cuts no figure, as it is substantially the same as that of No. 2. If it is the same judge who presided at the first trial, of course he could not be expected to back on his own judgement, and if it is another judge, he has to follow the precedents set by his predecessors.

The court takes the case under advisement in order to consult with Judge Precedent. The court finds a good many precedents though not exactly to the point, but after considerable search finds one that fits the case to a T. Now, the court being ready to render a decision, comes in and calls the case, and says that while there are a good many precedents bearing more or less upon the case, the one the court relies on as fully meeting the case, is the one set by Judge Buller, of London, about the year 1780, wherein he declared in court "that it was lawful for a man to beat his wife with a stick the thickness of his thumb." I therefore "decide against the surveyor," and appoint S. Y. R. to make a new survey.

Being rather a noted case, Surveyor No. 4 is determined to get it right. He spends some time in hunting up records, etc., runs and measures the line and makes the following report to the court:

STATE OF INDIANA,——COUNTY. }
C.—& D.—vs. S.—R.—et. al. } Cause 89876.

To the Hon. ———, Judge of the ——— Circuit Court:

In the above entitled cause I have the honor to make the following report:

As the case has been attracting some attention I conceived it to be my duty to get the best information I could, in order that I might be able to make the survey as correct as possible, and having had the pleasure, frequently, of listening to your honor's learned discussions on your findings and decree in similar cases, I have adopted your line of thought, as

expressed in your findings and decrees, throughout in making the survey ordered by the court in this case. I have therefore paid no attention to the laws, to right, justice or merits of the case, (none of these being within the province of the surveyor,) but confined myself entirely to precedent and preceded on the — day of —, 18—, to make the survey in accordance with all of the precedents I could find, all being alike. The line was run and measured, and the corner set by surveyor No. 2, and varified by surveyor No. 3, was found to be substantially correct.

And now I would ask the court to make an allowance for my regular fees amounting to \$5.70 and the additional amount of \$25.00 for five days searching for precedents.

All of which is respectfully submitted,

S. Y. R—— Surveyor.

The case now takes a rest for nearly three years when an appeal may be taken from the last survey and the story continued.

But I hear some one say that “the court don’t say that the stone put down, to mark the quarter section corner, by Surveyor No. 3 is not the quarter section corner.

Let us look at this a little and see what the court, by its decree, does say. The U. S. government by its officers (surveyors,) appointed for the purpose, established and marked the section and quarter section corners. The laws are plain and the instructions to the surveyors very explicit. Telling them, not only what to do, but how to do it, and how to make up the record in their field books. Not only the language but the words to be used and what words may be abbreviated. In case a corner becomes lost or obliterated there is an officer elected or appointed in the different counties in this state to relocate and establish such corner. Surveyor No. 2 was such an officer.

Now, in the case recited above, four men own a quarter section of land each, and the land is described so that there is one corner that is common to all four of the quarters. That corner is lost. Surveyor No. 2 is called on to run the section line and establish that corner, according to the deeds

of the owners and the laws governing such cases. He follows the law and does exactly, or as near as it is possible so to do, like Surveyor No. 1, (the original surveyor,) says in his field notes that he did, and sets a properly marked stone for the quarter section corner. Surveyor No. 2 has done precisely what he was called on to do, neither more nor less. Some of the parties appeal, and the court "decides against the surveyor," and enters up a decree and appoints another surveyor to make a new survey. If the court, by that decree, don't say that Surveyor No. 2 was wrong and the corner set by him was not in the right place, and was not the quarter section corner, then there is no meaning to language. If the corner stone is in the right place why does the court appoint some one to make a new survey?

Now, let B and D change places (not change characters) and follow the course of events as recited above, and C and D take an appeal from the survey as made by Surveyor No. 3, and it comes up for trial, five or six years after the survey had been made. Surveyor No. 3 has prepared a map showing the land belonging to the four men, the position of the fences, and that one corner (quarter section corner) is common to all four of the quarters. A friend gets hold of the map and points out that if the court decides in favor of the fence-standing-twenty-years theory, it will look rather awkward to make two corners a little over two rods apart, and common to four quarter sections. The court, after some deliberation, hits upon a plan to avoid such a ridiculously absurd position, and at the same time put the clerk under obligations, and possibly get one or two of his lawyer friends into a job, calls the attorneys in the case and tells them that he has been thinking for some time that it would be best to make two cases out of 89876. That there were four pieces of land and it would simplify to some extent as there would not be so many parties with conflicting interests in the separate cases. After consulting with their clients, with each other, and the court, for some time, it was finally agreed to. The court enters the agreement upon the docket and tells the clerk to enter upon the calendar for the next term, cause

143183, C vs. S. R. Y. et al, and 143184, D vs. S. R. Y. et al.

At the next term of court, all parties, in both cases, were ready for trial, with the same two lawyers, but, somehow or other J was defendant's counsel in the first case and in the other he was on the side of the plaintiff, while K was the opposing counsel in both cases.

The court calls 143183. All ready for trial. For prudential reasons the court had ordered 89876 to be divided, but the evidence in the offspring being so nearly identical with that in the parent case, the attorneys find it a more difficult undertaking than they at first imagined, as was proved by the sequel.

Mr. J, who was counsel for the defendant in the first case and was the plaintiff's counsel in the next, which was set for trial immediately after the first should be through with, knowing that the evidence would be the same in both cases, thinking to save time, provides himself with two parcels of paper, on one of which, as the trial proceeds, he makes memoranda and notes to be used in his argument for the defense in the first case, and on the other, notes to be used for the plaintiff in the next case. After the evidence is all in, by agreement of counsel, J makes the opening speech. But not having been as familiar with the "Australian System" as he should have been, the parcels of paper used were of the same color, so his notes got mixed and the papers becoming disarranged he picked up the notes intended to be used in the next case for the plaintiff and commenced his argument for the defense. When he got fairly started a broad smile was seen on the face of the opposing counsel, but when J got near the middle of his speech the smile on K's countenance had disappeared and his face was very much elongated and he was becoming excited. What was the matter? Something had struck him and from his appearance it must have hit hard. What was it? Why, it was an idea that J was setting some sort of a trap, or was working some underhanded trick to beat the case, for in all of his experience he had never heard such a line of argument pursued. And the longer he listened the more excited he became, being con-

vinced that a cyclone, as it were, was going to overwhelm him in utter defeat, and what was the more perplexing, he could make no defense. He could not make any preparation for meeting something, the nature of which he was ignorant, he fumbles the papers on the table, upsets the ink-stand, sets his client's hat out of the way, turns around and sits down, jumps up and makes an apology to the hat, which looks sorry—for him, and worked himself up to such a fever of excitement that when J wound up his argument for the defense, K could scarcely stand, much less say anything. Indeed, there was nothing to say, nothing to reply to. But he finally manages to articulate, "If, if your honor please, I-I will leave the-the argument with the court wi-without further case. A friend assists him to a seat. The court "decides against the surveyor" and appoints P to make a new survey, then calls the next case, gets through with that, "decides against the surveyor" and appoints Q to make a new survey.

P and Q understanding that there is only one corner to be fixed, meet and consult, and thinking that they might assist each other, make arrangements to go out on the same day to do the work. They then go to the clerk and get the order of court. But after reading it northly and southly, eastly and westly, latitudinally, longitudinally, double longitudinally, innumerable triangularlies, etc. etc., they cannot find the least hint and have not the remotest idea of what they are expected to do, in making the survey, so that the court will not "decide against the surveyor." Meeting with the judge one day they ask him what they must do in making that survey so that the court will not set it aside. He tells them that all they have to do is to obey the order of the court, make their surveys and hand in their reports. The Court will do the rest.

Failing to get an inkling from the Judge they hunt up all of the laws they can find on the subject of surveys and also find that Section 4867 R. S. Ind. says "When any person shall, by mistake, erect any fence on the lands of another, and when by a line legally determined, that fact is ascer-

tained, such person may enter upon such premises and remove the fence which may have been made thereon, within six months after such line has been run as aforesaid, etc., etc.”

Now P and Q very naturally conclude, that as the statutes gave C the right to enter upon the land of another to move the fence to the proper line, surely A would have the right to go onto his own land and move a fence that had been by mistake placed wrong although the statute says nothing about it. And there is nothing said in the statutes about how long the fence might have been standing, whether ten, twenty, or thirty years, before the mistake was discovered, i. e., before the line was run by the surveyor and “legally determined.”

P and Q, after examining all of the laws on the subject of how lands should be surveyed, and the abstract and title deeds of A, B, C and D, run and measure the section line and find that the corner set by Surveyor No. 2 is substantially correct, and conclude not to move it. C wants the corner set about a rod to the west, while D wants it placed about a rod to the east. P and Q tell them that they might get some surveyors to undertake to make water run up hill, but to put down a stone for a corner that was common to four quarter sections, and, at the same time, have the stone to stand in two places, over two rods apart, was a feat that they did not feel like trying to build a reputation on just then.

C and D wish to know how it comes that they leave the corner where the other surveyors placed it, when the Court decided against the other surveyors. P and Q say that they made the survey in accordance with the laws and the deeds, and that there is nothing in the deeds that gives C a shadow of color of title to one foot of land in section 8, or D any in section 9.

But why don't you make the survey in accordance with the order of Court? P and Q reply that the Court has not decided anything as yet. There is not the remotest hint that there is one foot, or any other quantity of land in section 8 belonging to C, or that there is any in section 9 belonging to D, or that any quantity of land whatever should be set off by

the surveyors, to C in section 8, or to D in section 9. P and Q say further, that if A, B, C and D will agree to put down corners, the surveyors are ready to do it. But in order to make the agreement effective the parties would have to sign and acknowledge it. So the simplest way to end the whole matter would be for A to make a deed to C, and B to make a deed to D for whatever amount of land that might be agreed upon, then the surveyors would have something to guide them in making the survey, otherwise they could do nothing.

They go to A's house, and while A and B are talking to their wives about the matter, P and Q are writing the deeds, which was all plain sailing until they came to the consideration part. That was a poser. For, while it would help the surveyors by giving them a deed to go by, it would open up a gap for the commencement of another lawsuit. For there would be plenty of lawyers to tell A and B that they had good cause of action under Sec. 306 R. S. Ind. P and Q finally conclude that the only thing they can do is to state the facts and let the future take care of itself. So they write two deeds like unto the following:

This indenture witnesseth, That A and wife convey and warrant to C the following described land, for and in consideration of having had the privilege of paying taxes on said lands, the receipts whereof they can show, for the last forty years, a part of the N. E. quarter, etc. But when A and B hear the deeds read, and are reminded of the taxes they had paid and remember the good crops gathered off the land by the other fellows, they very emphatically, in language more forcible than elegant, refuse to sign the deeds. So P and Q leave the corner where they found it and make their reports to the court.

The two years following bring many changes. A, B, C and D were called, by the great leveler, to the silent tomb. They were laid away in —— cemetery, and it so happens that they are on adjoining lots with one corner common to all four lots, but they sleep on peacefully, side by side, never more to be disturbed by surveyors, lawyers or courts.

A, B, C and D left a son each to whom they willed the land, on condition that the young men pay their sisters certain sums of money. The young men finding themselves considerably in debt and meeting with a chance to sell out, each takes the old deed and a copy of his father's will and goes to a conveyancer to have a deed written. The abstract is short, patent deed and will, nothing more, so the deeds are soon ready. But E, F, G and H, who are proposing to buy the lands, and wishing to have everything all right, each goes to a lawyer to get the abstract examined. The lawyers each go in turn and examine the records. The first finds everything straight except in the court records he finds, that about twenty-five years ago a lawsuit was commenced, and by tracing it along, term after term and year after year, up to a little over two years ago among the last records found was, that the court had decided against the surveyor and appointed P in one case and Q in the other, to make a new survey, and that they had made the survey and reported to the court. So the court has not decided anything as yet. Great Surwarrow! A quarter of a century and nothing done. And yet we are told that these fence-standing-twenty-years decisions are made to settle disputes and end law suits.

Why did not the court, on the first trial, make its decree of some effect, by ordering deeds to be prepared for A and B to sign, giving C and D a strip of A's and B's land, and if A and B refused to sign the deeds, send them (with their wives and children) to jail, until they would have been glad to have deeded their lands to the lawyers and the court, provided they would spare their lives and let them leave the country? But the lawyers don't want the farm. They can make more out of a farm if some one owns it that knows how to manage it, provided a law suit be kept going, than they could to run the farm themselves.

But we left the lawyers examining the abstract and court records. Let us see what they have found. The other three lawyers, in turn, find the same that the first one had, and all report to their clients that the title to the land they were buying was good, could not be better. There had been,

it was true, a little difficulty about the line, but if they were all disposed to do fair and right there need be no further trouble. (Which was all true enough, for if C and D had been honest like A and B a deal of trouble might have been saved and each had his full quarter section of land and \$2,500 in cash, as well as saved the lawyers and court officers the annoyance of handling and counting the \$10,000.)

The bargains are closed and the new purchasers take possession, E buying the N. E. quarter and H the S. E. quarter of section 8, T. 10, R. 12; F the S. W. quarter and G the N. W. quarter of section 9, same township and range.

When G and H find the quarter section corner in one place and the fences in another, they begin to make inquiries and find out how the matter stands. They knew that they only bought a quarter section of land each, and did not have a shadow of color of title to one foot more, but as they had been educated about the court house, E and F were surprised one day by the sheriff serving a notice on them of an appeal having been taken by G and H from the surveys made by P and Q nearly three years before.

When the transfers were made, the faces of the lawyers were considerably expanded, perpendicularly, for they thought that the goose which had served them so well was about to succumb to la grippe. But when they found out what school G and H had been educated in, their faces began to elongate, equatorially, the golden-egged goose was convalescent.

The judges and the lawyers talk the matter over, and say, "we must take care of G and H and help them out, for two such precious rogues will bring more grists to our mill in five years than twenty honest men would in forty." No wonder, then, that the lawyers and the courts are ready to tumble over each other in their indecent haste to hunt up precedents and make decisions in favor of their friends, the thieves and rogues.

After the appeal is taken, the whole court proceedings will be repeated over and over, again and again, and then and then continued a la New York *Ledger*.

But suppose there had been an honest man on the bench when the appeal was taken from the survey made by S. Y. R. After the evidence was in and the lawyers had had their say, the court would have said something like this: As this case is rather a noted one, I wish to make a few remarks before rendering a decision. And first, the opposing counsel in this case are to be complimented on their gentlemanly deportment and for their desire to have a fair and honest trial. Neither one has sought to take any unfair advantage of the other, for both have cited the court to sections of the statutes that have a bearing upon the case unfavorable to to their own clients.

This case is on an appeal taken by C, from a survey made by S. Y. R., and the only question in it is, as to the correctness of the survey. The appeal should have been taken to the surveyor's court, but as the legislature has not, as yet, authorized the Governor to appoint a Commission of Surveyors to settle such cases, it was the best that could be done under the circumstances, and as we have it here, will try to dispose of it.

The laws governing the mode of surveying are very plain. We have the records of the original surveyor's field notes, and we have the evidence of Surveyors No. 2, 3 and 4, with their assistants, chainmen, etc., that they made the survey, as nearly as it was possible for it to be done, precisely as the original survey had been made.

But there are several other questions that have been brought in by the counsel, and admitted by the former court, to be disposed of. The questions are very proper ones to come before this court, but why they were admitted in this appeal from the surveyor is not so clear. But it seems to be a kind of polygonal suit with x sides.

From notes of the evidence taken by the court it appears that C and D, a number of years ago, finding circumstances favorable, planned a scheme to steal some land belonging to A and B, and a little after twenty years afterward came into court to get its assistance in completing the theft by confirming their actions, quieting title, etc.

Under the limitation statute, A had fifteen years, after the survey was made, in which to bring action, for it was impossible for him to have known to a certainty that he had any cause of action until a survey had been made.

The court sustains the surveyor and confirms the survey as made by him.

The evidence shows that the land was worth \$2.00 per acre per year and that C has had the use of a half acre of A's land for forty-four years. The court therefore decrees that C shall pay to A \$1.00 per year and interest annually for forty-four years, and further, that C and his attorneys shall pay all costs of this suit, including A's attorney's fees, with interest, etc., amounting to \$3,850.

The next case is disposed of in like manner, when J goes to his client A and says, "We beat 'em," pockets a good fee and goes to his client D and says, "We've got 'em just where we want 'em, the supreme court will reverse that case so quick it'll make their heads swim," and pockets another good fee.

But that decision was a bomb in the lawyers' camp. They hastily congregate in a back room, select a chairman, and appoint a committee to wait upon the press reporters and have it go into the papers that the decision was on some technicalities and there would be a new trial. It would never do to have the facts get to the people.

One makes a motion to have the Judge arrested for anarchy and throwing bombs, but others say that the best way is to say nothing about it and if anybody speaks to you about it turn it off as of no consequence, because if the people get to thinking too much they might send men to the legislature who would pass different laws, then we may have to change our business. If we had such laws and such judges it wouldn't be ten years before we would see a card on the court-room door, "TO LET. Inquire at the Auditor's office."

If the fence-standing-twenty-years theory is to maintain, we had better abolish the office of County Recorder and save a million dollars every ten years to the people of the state.

If the legislature takes a few more steps, making the statute ten, five or one year, and then one step more in the same direction, if you get possession of the land it is yours, then you will see the farmers out with their guns at night, on the watch for fear they might get up some morning and find the fence moved and some one in possession of their corn, or wheat field.

Instead of the laws and the courts protecting the honest man in his rights, honest men have to defend themselves against the laws and the courts, as well as against the thieves and rogues.

R. A. HOWARD,

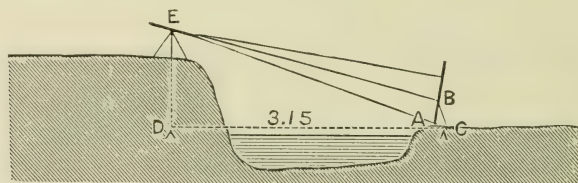
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STADIA MEASUREMENT IN LAND SURVEYING.

It is not the object, in presenting this paper, to enter into a discussion of all the fundamental principles, or the numerous formula, upon which stadia measurements are based, but it is rather in relation to the utility and practical application of the stadia, in the ordinary practice of surveying, in instances where streams, ravines, hill sides, swamps or other obstacles intervene to make chain measurements difficult. The stadia is not a new contrivance, but as yet is not very generally used by county surveyors. Although not now actively engaged in surveying, I have used it more or less for a long time, and I know of no other contrivance or method equal to it, because of its simplicity, convenience, and easy method of measuring distances, especially in such cases as above alluded to, and it is in such cases that I have found it a very useful attachment to the transit.

Some men, however, have no inclination or desire to work with novelties, and others have not the patience to investigate, or learn their use, and to this cause, perhaps, more than any other, may be attributed the reason why the stadia is not in more general use. Some, also, are doubtful as to the accuracy of stadia measurements. They might, also, as well doubt the accuracy of the solar attachment, or the prac-

tical method of measuring distances by trigonometrical calculation; stadia measurement is only another form or method for doing the same thing. Vertical angles are just as easily measured as horizontal angles and, by the use of the stadia, with far less trouble, especially where the line being run comes to a stream or ravine at a point where the bluff rises perpendicular, and the surface of the ground to the left and right is very much inclined, and rugged and on the opposite side of the stream very low ground, making the problem more complicated; and it is no uncommon thing for the surveyor to find himself in just such a place, an illustration of which is here given in the "Figure."



This "Figure," also illustrates the manner of holding the rod, which I use, which will be explained further on in this article.

Where the elevation of the ground on both sides is about the same, the rod must be held vertical; in such cases the distance is read direct from the rod without any other calculation. But in cases of angles of elevation or depression, the only correct way is to hold the rod vertical, unless the surveyor is provided with a rod especially made for the purpose, like the one which I have above alluded to, which may be held at right angles to the visual line, thus obviating the reduction of the angle formed by the rod within the visual line, which also admits the distance intercepted by the wires, on the rod, to be read off and noted without any other calculation. Then to find the horizontal distance, DC , the surveyor has only to reduce the vertical angle found by the arc, by multiplying the distance found, EB , by the cosine of the angle. It will be seen, however, by the "Figure," that the distance read off, when the rod is held perpendicular to

the line of sight, is not to the foot of the rod, A, but is to a point C, vertically under the point B, cut by the center wire. It must also be remembered that for every sight taken, there must be added the "constant" for the instrument, which in the average has been found to be about 12 inches.

The rod which I have mentioned above, is one which I had made according to my own ideas. It consists of a straight piece of pine wood, is about one and one-eighth inches thick, two and one-half inches wide and ten feet long, graduated on one side in feet and hundredths, from bottom to top, same as the self reading leveling rod. The other side has a fixed target in the center, and is graduated in feet and hundredths, reading up and down, each way out from the center.

The edges are painted red and white alternately, and when held with the edge to the surveyor, it becomes an excellent range pole. It also has attached to it, by a bolt through the center, a standard, G B, shown in the "Figure," which is always to be held vertical, which is accomplished by a horizontal level attached to it. The rod is also provided with a vertical circle reading to single minutes, by a vernier working within the circle, which is attached to the standard, and no matter what the angle may be, as read from the arc on the transit, the rod can be set to read the same, then holding the standard vertical by means of its level, the graduated rod will be inclined to a position exactly perpendicular to the line of sight.

This rod I have found to be very convenient, and other conditions being equal, the method is as correct as any other.

The convenience and utility, of stadia measurement I have found in my own practice as illustrated in the following instances.

While serving as Surveyor of Carroll County, some years ago the County Board made an order to erect an iron bridge over the Wabash river at the town of Pittsburgh, and directed me to ascertain the distance across the river, so that specifications might be prepared. It was at the March term, and the river was very high. Having a transit fitted with stadia

hairs, set for one foot on the rod to one hundred distant, I sent a man over with a common leveling rod, and sighted him in line, and had a peg set at a convenient point, and now made three observations on the rod, and found that the average reading was six feet, which indicated a distance of six hundred feet, from which I concluded that a bridge six hundred feet long was what was required, and so reported to the Board. Afterward when the water got down, I was told by the man who was appointed as superintendent, that he measured the distance with a steel line, and that my peg was only four inches out of place, which was surely close enough for the purpose which it was set.

At another time when running a section line, we came to one of those old "beaver dams," common all over Northern Indiana, forming a pond, in which the water at the time was two or three feet deep, and being in the early spring was very cold; I had the chainmen measure up to the instrument, and noted the distance, and sent the flagman around the pond and sighted him in line and had him set a peg in line a little way back from the water.

The wires were set for one foot on the rod to sixty six feet distance; found the reading to 5.10 which indicated a distance of five chains and ten links, to this I added for the instrument one and one-half links, and proceeded, being confident that the measurement was fully as accurate as if the chain had been dragged through the pond, even though it had been dry.

A year or so ago I was called to run out a line for a road, which had been located on the middle line of the section; the township trustee had given notice to interested parties, by publication, and when the time came around it happened to be the coldest day of the season, the mercury being 15 deg. below, but notice having been given it was necessary to do the work or go and postpone it to another day, and so I proceeded to the place of meeting, and finding the parties anxious to have the work done, we went on, and finding the quarter section corner without much trouble, started east at random, and at a distance of 22.25 chains came to the bank of Deer Creek,

which was 35 or 40 feet above the land on the opposite side of the stream, the bluff was almost perpendicular, and was covered with a thick mat of brush and briars, and the ground was considerably inclined to the right and left, (the figure shown on page 100 was suggested by this place), and would be a difficult place to measure at any time, and to make it more difficult now, the wind was blowing across the field behind me at a fearful rate, and the air was full of flying frost, and at this place too, the creek was open, it being a riffle on which the water was about two feet deep, and very rapid. I made a note of the chaining up to this point, and sent a man over with the rod, (a common leveling rod), and sighted him in line, and had a peg set; took a reading on the rod, having it inclined from me, until the readings above and below a certain point on the rod were equal, which indicated that the rod was now about perpendicular to the line of sight, the wires being set for one foot to sixty-six, the space covered by the wires on the rod was 3.20 and the angle read off the vertical arc, was 10 deg. 15 min., my fingers were now nearly stiff from cold, too cold to hold a pencil to make the reduction of the vertical angle, so I got out a table book containing a traverse table; called the reading on the rod, ($+ 1\frac{1}{2}$ links) "distance", and the angle of depression "bearing", and took latitude for horizontal distance, 3.15 chains. As a check now I took a back sight, having sent the rod back, and reducing the angle of elevation, the result was the same, and having set the chainmen right we proceeded on through the section, correcting the line in our return.

In running a line recently, we crossed a deep ravine, and in holding the chain so as to measure horizontal, using a part of it at a time, the forward chainman left a pin, before he had measured a full length, consequently the line appeared too long.

This was not discovered for several days, and was the cause of considerable trouble and annoyance. Had I used the stadia the mistake would not have occurred, and I am sure the measurement would have been fully as accurate.

I do not wish to be understood as advocating an idea that

stadia measurement is superior to the chain or tape, under favorable circumstances, but in such cases as I have described herein, I have certainly found it of great convenience, and under such circumstances as related I would give it the preference.

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IN THE MOUNTAINS OF UTAH.

F. HODGMAN.

When I was a boy I read over and over again with great delight Fremont's narration of his exploring expeditions, and I have wished time and again that more of the hardy adventurers, who were the real pioneer explorers of our country had left to the world the history of what they saw and did. No class of men have done more of this work than the surveyors. The rectangular web of the United States survey extends from the great lakes to the Gulf of Mexico, from Florida to Oregon, and railroads span the continent from ocean to ocean. What does the world know of the men who spun the web, and run the lines, and drove the stakes, and built the roads? Very little; and of the vast majority, nothing either of the men or the history of their work. Nearly forty years after Fremont's work it happened to be my fortune to assist, in a subordinate way, in opening to the world a part of the great west that Fremont had passed by on either side and which, up to that time, so far as the world at large knew, was an untrodden wilderness. True, the Ute, and the grizzly, and the Mormon, and the trapper had been there, but what they knew they kept to themselves. It was in February of 1881 that I was called upon to take a position as transit man for a locating party in the employ of the Denver & Rio Grande Railroad. I met others of the party in Chicago where we purchased an outfit of blankets, medicines, arms and ammunition, and got orders to report in Salt Lake City. This we

did on the 22d. Here we spent a few days in further preparations. We were going into an unknown country where the Ute and the grizzly were supposed to hold full sway. We were cautioned to be secret and tell no one where we were going or what we were going for. In fact, none of the party knew themselves where we were going—except the chief of the party, Mr. F. P. Davis,—and he only knew in a general way. We knew we were going far from settlements to be gone an unknown length of time and made our preparations accordingly. Additional blankets were purchased and stout canvass sheets to roll them up in. Stout suits of heavy cotton duck clothing took the place of our woolen, and every man had his pair of rubber boots. In our leisure moments, which were not many, we saw what we could of the city. Our hotel—the Continental—was a two-story building built of adobes, but the rooms were neat and the fare unexceptionable. The city is beautifully located on a comparatively level plateau at the foot of the Wasatch mountains and overlooking the Great Salt Lake valley. It is laid out in squares of about ten acres each, with broad streets between, down each side of which swiftly flowing little rivulets distributed from a mountain stream furnish water for irrigating and culinary purposes. There is a little water gate opposite each man's lot through which he takes the water as he needs it. Every man and his hog and horse and cow drink from the same ditch. Thrifty growing shade trees line the streets, which are wide enough for a little park on either side of the roadway. In the center of the city is Temple Square, which contains the great tabernacle and the new temple and the assembly hall. All around the square is a high stone wall forbidding entrance to the gentile except by permission of the saints. It was endowment day when we went to visit the temple and we were not allowed inside the walls. Many of the old Mormon residences are surrounded by similar forbidding walls, so that if any peeping Tom wants to take a squint at the harem he will have to climb a ladder for it. A very handy system is in use for naming the streets. Those adjoining Temple Square are named respectively North, South, East and West Temple

streets. All the other streets are named and numbered from these, as, for instance, 4th North Temple street, or 9th East Temple street. The city at that time, as nearly as I can judge, was about as large as South Bend is now. Its great beauty was in the location, its broad streets and the regularity with which they were laid out. The buildings, as a rule, would not compare in beauty or comfort with those of cities of similar size east of the Mississippi. A majority of them were such as could be built for \$600 or less—many of them a great deal less. The most pretentious business building which I saw was the Zions Mercantile Co-operative Association, where all kinds of merchandise are sold: dry goods, groceries, drugs, paints, clothing, harness, hardware, carpets, boots and shoes, and so on to the end of the chapter, each having its separate apartment, and a large stock was carried. The Mormons have carried the co-operative principle much farther than any other people in America. This great concern in Salt Lake City was the head of the system and every Mormon settlement of any size in America has its branch co-op.-store which the people have to make their purchases from, and which in turn are supplied from the great co-op.-store in Salt Lake City. When I left home it was mid-winter, keen and cold with snow lying deep on the ground. There it was warm and spring-like. The black birds were singing and people were preparing to plant their gardens.

After getting our outfit we left the city on the morning of the 27th, via the Utah Southern R. R., bound for Castle Valley, wherever that was. Nobody seemed to know anything of it only it was on the opposite side of the Wasatch mountains from us, and to get there we must skirt down the western slope of the range for about 200 miles before reaching a pass through, or over which we could cross the mountains at that time of the year, and then we must turn north again to regain lost ground. It was as warm as a May morning when the cars rolled out of the station bearing us southward. Spring plowing had commenced. The farms were small, the houses poor, built up of logs or stone laid up dry and covered with earth put on top of a layer of poles and brush or hay.

Everything looks as foreign as the men who dwell there. On one side of us the Wasatch mountains rose to a height of 8,000 to 12,000 feet. On the other side the river Jordan wound its way through the valley to the Great Salt Lake—here and there spreading out into reedy marshes—and beyond it were the blue and hazy peaks of the Oquirrh mountains. We pass a plenty of oddly named towns as we climb along the base of the mountains. At Provo is a noted co-op. factory where the greater part of the woolen blankets used in this country are woven. Here when a man goes out for a journey he takes his bed and provisions with him. His bed consists of a pair or two of Provo blankets. If he goes on horseback he makes his bed on the ground with the blue dome of the sky for his roof. If he goes with a wagon that is his bedstead and tent. Noon found us at Juab, a little town consisting of a water tank and two hotels, such as they were. Here we left the railroad and took a spring wagon to cross the country to Salina. We climbed a rough and muddy road up a valley which contracts as we ascend, and the stream dwindles till it disappears entirely. Here and there the ashes of a camp-fire, a broken bottle, an empty tin can and a bacon rind tell us where some traveller has spent the night. Presently we pass the summit of the Juab valley and begin to descend in to the valley of the Sevier river.

Mount Nebo, 12,000 feet high and covered with snow towers above us on our left. Far ahead the wedge-shaped peak of "Mollie's Nipple" pierces the sky. There are mountains at the right of us and mountains at the left of us covered with snow. Before us a valley opens out with low foot hills at our feet and on either side decked out in the most beautiful delicate colors of every shade and gradation of tint that can be conceived, altogether making a picture beautiful and grand beyond the power of description, a picture that a man will carry with him to his last resting place.

The sun disappears, there is no moon, but we push on with only the stars to light us on our way, till the thump of the wagon as it crosses some irrigating ditches, tells us we are approaching human habitation again. Presently we cross

a small stream from which thick clouds of steam are rising in the frosty air, and pull up at an earth covered log house, the hotel of the village of Warm Springs, where we got supper, spread our blanktes on the floor and began our experience of sleeping without a bed. Next morning at ten o'clock we reached Salina which was then the headquarters of the Sevier Valley R. R., a local name for the western extension of the Denver & Rio Grande. It was a little village of 300 or 400 inhabitants at the mouth of Salt Creek, the western entrance to Salt Creek Canyon—the only pass by which we could now cross the mountains. All about here the rock for miles are impregnated with salt. Crystals of gypsum sparkle in the sun in every direction. Considerable salt of an inferior quality is made here.

Here we organized for the wilderness and awaited the arrival of a pack train of mules which left Salt Lake City several days before us, before starting for the unknown country. It arrived after a few days and then we were off. One wagon drawn by four horses starts with us to go as far as the roads will permit, when it is to return and everything is to be packed. Our baggage is all put into the smallest possible compass and everything that can be spared is left behind. What remains is put into a common two-bushel bag and strapped onto a mule. As we start out of town we meet a party of engineers just in from Colorado, rough and travel worn, who give a dismal account of the country they have come through. We skirt along the foot of the mountains a short distance when an opening appears at our left through which a brook comes tumbling down. There is no snow here and the rugged rocks and mountain sides are decked out in all the colors of the rainbow. A railroad line is staked out here and men are grading in places. As we move on up the pass the valley narrows and the rocky sides rise steeper and higher. A wagon road is dug out in places along the mountain side. But it is a dangerous place to pass and more than one wagon has taken a roll down into the stream below. The cliffs are from 500 to 2,000 feet high on either side and in places it would seem as though the road were coming to an

abrupt end, walled in on every side. But an opening is sure to present itself, on the one hand or the other, and we pass on. The third day out the valley widens and we enter Meadow Gulch. This is a meadow-like valley, a mile wide and several miles long, well up toward the summit of the pass. The snow was lying several feet deep in the valley and the road was obliterated by the drifted snow. Five of us on foot had left the wagon and pack train miles behind us. We found the tramp up the gulch a hard one—following the road mainly by the sense of feeling, as when we stepped out of it we went down deep in the snow. By the middle of the afternoon we had passed the Gulch and reached a hut and corral where we could see back over the road we had come, and we looked eagerly for our train, but it was not in sight. After waiting till nearly night without their showing up, two of our party turned back to meet them, but O'Neill and I preferred to stay where we were, dinnerless, supperless and bedless, rather than make two more trips across that cold and dreary Meadow Gulch. Presently two rough looking men armed to the teeth and driving a pack-horse rode up and proceeded to make themselves at home. A fire was started in the fireplace in the corner of the hut, coffee made and some bacon fried. These with a loaf of bread made a supper which we were invited to join in partaking. They might have been the worst of outlaws for all we knew, but their coffee and bacon tasted good. About nine o'clock our two men returned with two pack mules loaded with our blankets and provisions, and we were made as comfortable as circumstances would permit. Two days more took us over the mountains into Castle Valley, passing a single residence on the way, the only one we had seen since leaving Salina. Here, at the entrance to Castle Valley, we found the camp of H. D. Wilbur, who was farthest out of any of the engineers in the company's employ. We were now out of feed for the animals and had to stop until we could send back to Salina for a fresh supply. The time was spent in hunting and exploring the valley.

Castle Valley is, perhaps, a hundred miles long, north and south, and from five to thirty miles wide. It is bounded on the

north by the Book Cliffs, on the south-east by the San Rafael Swells and on the west by the Wasatch mountains. It is mostly a desert, having several plateaus varying a few hundred feet in their elevation, with occasionally a conical hill rising up from two to four hundred feet above the general level. The mountains on either side rise precipitously with vertical walls facing the valley to the height of many hundreds of feet, then slope back for a distance and rise again as much more, like stories in a great building, each story smaller than the one below it. Several streams cross the valley at various places, coming down from the Wasatch mountains and passing out to the east and south-east by tremendous canyons to the Colorado river. It would seem as though the whole valley had dropped down bodily from the surrounding country. There is a theory that it has been brought to its present shape by the burning out of the coal fields which out-crop about it. There is plenty of coal here and some of the veins are said to be 17 feet in thickness. It is on fire in places now. Numerous pyramids and great monoliths have been separated from the main ranges and stand like sentinels about the valley. Wierd forms that look like castles of old with towers and domes and battlements stand out on every side, and we almost expect to meet some old feudal baron marching out from their walls at the head of his mail clad warriors. Tributary to the streams are numerous channels, called washes, which bring down water in times of rain. They are all dry now, and their banks rise vertically from the bottom. Some of them are but a few inches wide and perhaps a dozen feet deep and others are hundreds of feet wide and as deep as they are wide. As we passed on up the valley we found a few Mormon settlements. These were located on the streams at Ferron's, Cottonwood and Huntington Creeks. The settlers were foreigners—Danes predominating. Their dwellings were of the rudest description—log huts covered with brush, hay and earth for roofing. Wherever there is a settler there is an irrigating ditch, for no crops can be raised without irrigation, and this confines the settlements to the vicinity of the streams. The streams are small in summer

and the irrigation of any large amount of land would take it all. A judicious system of reservoirs along the streams and washes to store up the freshet water, for time of need, would largely increase the amount of tillable land. We struck the Price river a dozen miles beyond the farthest settlement, in a comparatively level country and followed it down a few miles where we pitched our camp and began business. The best point we could find was selected for a river crossing and a line started toward Colorado. The first few days we spent in reconnaissances. The Price river was then a small stream fifteen or twenty feet wide and a foot deep with many deeper pools along its course. Except in the rapids its surface was still frozen and we could cross on the ice. The carcasses of dead cattle and sheep lined the stream as far as we could see and not a stretch of a thousand feet could be found where there were no carcasses in the stream. It was not uncommon to find twenty or thirty or more sheep lying in the water together. We had to use the water for there was no other. The stream runs in an easterly direction across the northern and broadest end of Castle Valley and reaches the Green river by cutting tremendous canons through the Cedar mountain and Book Cliffs.

It was the original design of the road to enter the valley from the east at its northern end and running thence southwesterly along the valley, cross the Wasatch Range over the Salt Creek pass and running thence westward cross Nevada and California to the Pacific coast. Another line was to run south into Mexico, crossing the Colorado river on a bridge 600 feet above the water in the Grand Canon. A side issue was to build a branch line to Salt Lake City and Ogden. We were started in at the point where it was supposed the junction might be made between the main line and the Salt Lake branch, to work eastward and meet parties who were working westward in Colorado. A party was in the field between us and Salt Lake City searching for a line over the Wasatch mountains, but as we afterward learned, they were practically snowed under and unable to make any progress. After selecting a crossing point, we made an examination

down the river and soon found ourselves in a deep canon which it seemed best to avoid if possible. Hence we started a line across a low divide and six miles away entered the valley of the Grassy Trail Creek, now dry. This we followed down to its junction with the Price, about sixteen miles from our starting point. The country showed everywhere the plainest marks of volcanic action. Extinct craters, piles of ashes and scoriæ met us on every hand. The sandstone rocks were burned till the surface was vitrified so hard that it was very difficult to mark it with a cold chisel. Under the sandstone strata was a clay rock which rapidly disintegrated when blasted out and exposed to the weather. In many places we met with tall monuments standing several hundred feet high and as slim and graceful in their proportions as Bunker Hill Monument. They stood like sentinels about the valley and often at a distance of a quarter of a mile or more from the bluffs from which they had become detached. We saw many others in the process of formation. The main part of these monoliths is of the clay rock, but invariably having a cap of hard vitrified sandstone. The softer rock was generally worn away under the caps until the caps jutted out over the base often as much as fifteen or twenty feet. When the process has gone far enough these rims of sandstone break off and fall. We found many pebbles of various colors, hard as agate and beautifully polished by the winds and flying sand. In one place was a tall vertical bluff whose walls were filled with round stones like cannon balls which were sticking there as if fired from a cannon. Many of them had fallen and we cracked some of them open. They were easily broken. Some were hollow geodes filled with crystals of some kind and others were seamed through and through with agate.

The valley of the Grassy Trail was very tortuous and a difficult one to locate in. It was comparatively level in the valley, but hemmed in by vertical cliffs which, in places, would approach within a hundred feet of each other, and again would spread out a thousand feet apart. There was very little timber standing in the valley, but in places there

were acres of thick cottonwoods from two inches to two feet and a half in diameter, which were lying flat on the ground, cut down by the beavers. It looked like a Michigan slashing. Our line was generally located by the eye and the cut and try method; but when we came to a tough place we adopted different tactics. I was running the transit, and in such places I ran a line wherever I could the easiest and quickest without putting in any curves. From each point where the transit was set up I took observations on all the salient points at the foot of the bluffs on either side and along the bed of the stream. This was done by sending the leveler's rodman with his rod to these points and taking the distance by the stadia and noting the direction by its angle from the transit line. The stadia wires were adjustable and set to cover two feet on the rod when it was 400 feet from the center of the instrument. This gave results sufficiently accurate for our purpose. When we had passed the hard point in this way, we went into camp, mapped the ground and located our line on the map. Then we reproduced the located line on the ground. On one occasion we made our preliminary survey of a mile and a half of the valley in one forenoon, mapped it in the afternoon and located the line on the ground the next forenoon. About a year later another party spent nearly two weeks in a vain attempt to better the location at that point. We were greatly troubled for water, here. There were pools of stagnant water in places in the creek bed. It was April and the days were hot, and we had to haul water from the river ten miles away for both man and beast. The river was rising and muddy and by the time the water had come ten miles through the hot sun it was not very palatable. A little farther down the creek we found some beautiful clear springs in its bed from which there flowed a constant stream. We used the water a few days and it acted on us very much as if we had been taking salts and we had to abandon its use. All scattered through this country were large flocks of sheep of 1,500 to 2,000 in a flock, each flock having its shepherd and dogs to look after it. These shepherds spend their whole time with the sheep, much of the time far away from human

habitation and seldom seeing a human face or hearing a human voice, except when about once a month, the owner or his agent brings them their supplies of provisions and other necessities, or assists in moving camp, which is done as often as the pasturage in the vicinity is eaten up. There were also herds of cattle and horses roaming about at will. On the last day of April our line reached the Price river again. That afternoon the chief of the party left us and rode off to Major Hurd's camp at the point where we had started our line a month before, not intending to return until next day. Major Hurd was the principal assistant engineer and had charge of all the work for some 200 miles. We were encamped at the foot of a high bluff and as close to it as possible. We had with the party one of Major Hurd's burros which was used to carry the stakes along the line and a very useful little animal he was, too. He was a jack and the boys called him Beecher in honor of the eminent preacher. About midnight Beecher set up a most unearthly braying, which awoke us from our slumbers, and soon we heard the rush of feet all around and through camp and over the tent ropes and the voice of Chief Davis shouting, "Help! Help! Shoot him! Kill the d—d jack. Kill him!" We tumbled out in short order and on getting outside the tent saw in the dim light two burros tearing about the camp and Davis on horseback after them shouting with all his might. The burros were soon secured and the mystery solved. On his arrival at Major Hurd's camp Davis had found a large force of men on the ground ready for work and not a stake set for them and nobody there to do it. He was ordered right back to camp to send me back to take charge of the construction. Beecher's mate, a plump young jennet, had a fine transit packed on her back and Davis turned about and rode back to camp driving the jennet with the transit. Beecher smelled the cavalcade from afar and set up the braying which awoke us. He made a rush for his mate and Davis made a rush for both to save the transit from its perilous ride, and that was the cause of all the commotion. From the rumors that had reached us we were looking for an encounter with the Ute

Indians, and this was our first Indian scare. Davis never liked to hear it alluded to. The next morning "Texas Bill," the teamster, hitched his mules to the wagon, loaded my things into it and we started on the back trail for the crossing of the Price. As we follow up the creek we hear an occasional splash as a beaver slides down the bank into some pool and we see his wake in the water. We pass the springs and follow up the open valley. The bluffs rise sharply on either side, their red monotony of color relieved here and there by a stunted cedar or a pinon pine. Now and then we pass a "wash" with ragged shelves of rock jutting out bearing mute witness of the dashing waterfalls and roaring torrents which pass over them when there is running water in the now dry beds. Here the bluffs come close together at a sharp bend in the valley called "Fiddler's Elbow," and on either side are strewn long windrows of driftwood fifty feet above the dry bed of the stream. There has been a big torrent here sometime and the like may come again any year. Woe to the railroad swept by such a torrent as that must have been. As we go on up stream we strike a wagon road along the old Spanish trail followed by Albert Sidney Johnson's army years ago when, as the Mormons say, they and the Lord drove him out of the country.

Presently the bed of the stream has risen till we are nearly on a level with the top of the bluffs we have been riding between.

The Book Cliffs, great white capped mountains, stand boldly out to greet us on the right five or six miles away, and the Cedar mountains face them as far away to the left. Right in front of us and fifty miles away the grim Wasatch range completes the triangle of mountain ranges which enclose this wonderful Castle Valley. Yonder is a chasm opening into the heart of Book Cliffs. It is the Soldier Canon; and just beyond the canon is Emma Park where the sheep have been driven for the shearing. Just to the left of Soldier Canon another opening is seen in the mountains. No one seems to know anything about it. Still further to the left and past the corner of the triangle, we see a rent in the Wasatch Range.

A spur of the mountain stands out across its mouth with an immense rocky column standing out like a sentinel over the valley. It looks like a great box piled on top of a lot of several smaller ones which stand on end one above the other. We can only guess at its size. It is thirty miles away and stands a thousand feet or more above the valley. The top is so much larger than its base that it seems as if it must topple over with the first heavy wind. The mountain spur, on whose point it stands, is a vertical cliff on the side toward the valley. A talus of loose rock and earth slopes away at its foot, but is now hidden from our sight by the trees on a plateau between us. The parti colored strata of rocks stretch away horizontally like ribbons. Some one detects a likeness to a steam-boat, and we call it Steam-boat Point. Now we leave the Spanish trail, and striking to the left, follow our line of stakes over the gentle divide into the valley of the Price again.

Here and there we came to a network of small washes and have to make a long detour to pass them. Here is one that you can step across, but it is twenty feet deep. The wagon must go around it but we step across and take a bee-line for the tents we can see away yonder by those two lone cottonwoods. The ground is as smooth as a floor, and as soon as we have passed these small washes we shall have plain sailing and perhaps get a shot at a deer or a hare. The sun is sloping towards the west, and thousands of sparkling diamonds are glistening in its rays. We pick up the finest one we can see, but it is only a crystal of gypsum, clear as glass, which has reflected the sun's rays in our eyes. The earth is full of them. We fill our pockets and push along. But, hold! What is this? A chasm 200 feet deep opening at our feet without warning. Ten rods away all seems smooth ahead, and here is this chasm 300 or 400 feet wide and half as deep. It is only a wash, like the little ones we jumped, except for size. We follow its edge seeking a place to descend into its bottom, which is smooth and level, except as it descends towards the river. The edges are nicked here and there by great cracks, which we jump as we go. Here

are two of them which have cut off a column from the side, leaving it standing out alone like an immense chimney. There are dozens of others like it in all stages of formation. Now we have found a place where by careful stepping we can descend into the wash, and an hour's walk brings us to camp, at the same point where we had camped more than a month before. Then our party and a few scattering shepherds were the only people in the country for miles around. Now it was alive with men. A large number of contractors with nearly five hundred men were on the ground waiting impatiently for work, and well they might be impatient. Their provision, hay and grain, had to be hauled 200 miles, and the freight alone cost them four and five cents a pound. They had been out on the proposed line of the road with the chief engineer soon after our party began work, and had taken each one so many miles of road to grade during the summer, which was to be assigned them in parcels of half a mile or more, wherever the resident engineer saw fit to place them. They are here waiting for work and no work ready. I was given a tent, a transit, a level and a dutchman and placed in charge. I had no provisions, no cook, no stationery, a big job on my hands and insufficient help. In place of the missing articles, I had some fine promises. In the meantime I must board with the contractors and get help of them to assist in laying out the work. They were, for the most part, Danes and Mormons. Each contractor was assigned a mile or half a mile of work and they immediately moved onto the ground and fixed their camps. I pitched my tent near one named Jacobson, with whom I was to take my meals. The snow was now melting off from the mountains and the river rising rapidly. All night and all day long we would hear the boom, boom, boom of the falling earth as it tumbled into the river in great masses of many tons in weight, as the rushing torrent undermined it. It had been a terrible trial to us to use the river water when we knew that only a few rods away a dead animal was rotting in the margin of the water, but there had been no escape from it. But now the rising torrent swept them all away and we could fill

our buckets with water and know that it contained nothing worse than half its bulk of river mud. That was easily disposed of. There were lots of cactus plants growing all around, and a single leaf cut in two and put in the pail would carry all the sediment to the bottom and leave it clear in a few minutes. The thick viscid juice of the plant caught and held the sediment together. Jacobson's party numbered about fifty, young and middle aged men, who worked together on the co-operative plan, he being chosen, by common consent, as leader and boss. When I first sat down to eat with him I was surprised to hear him call on one of the men to ask a blessing, which was done without hesitation. I learned that this party never partook of a meal without some one of the number first asking a Divine blessing. Their teams were mostly horses, though there were a few mules in the outfit. They were hardy, wirey animals of about 1,000 pounds weight, and were hard worked and well cared for, always looking in good condition. This party permitted no swearing. They understood their business, and it is perhaps needless to add, earned more money, per capita, than any other outfit on the line. They were exceptional men, especially in the matter of swearing. Mormons are peculiar about that. We soon learned that if we wanted to find out if a man was a Mormon we had only to wait till we heard him swear. If he said "by hell," we had a sure thing of it, for that is their standard oath. "S— of a b—" is a great favorite with them as an expletive. One day a whirlwind came along, and as the cook of one of the parties said, "the s— of a b— of a whirlwind came into his tent, raised hell, and turned around and went out again." Another party had a cow to furnish milk, but as one of them said, "the son of a bitch of a cow ran off and they had to do without."

I had been engaged only three days in construction at that point when I was astonished to see Davis' whole party, whom I supposed to be locating line twenty miles away, coming into Major Hurd's camp. That night I got orders to abandon the work at that point and take all the contractors and men up the river eight miles, where a new line would be

started as soon as the surveying parties could locate it. The next day I was there and found the chief engineer on the ground and two parties at work locating lines from the river in opposite directions. A twelve mile division extending from the river, crossing up the river several miles into the Price Canon of the Wasatch mountains, was assigned to my charge and the men once more set to work.

It was the first week in May that work began on the new line. Instead of following down the Price river to the Green and thence across to the Grand as at first contemplated, it was decided to cross the Price river some eight miles higher up stream and swinging to the southward, flank the Cedar mountains and winding over the San Rafael swells, reach the Green river some fifteen or twenty miles lower down. By this route the Cedar mesa and Book Cliff canons of the Price and the canon of the Green would be avoided and in their place would be the San Rafael summit to surmount. What these canons contained no one seem to know. Parties sent out to explore united with the stockmen in saying that they were impassable. We had found no insurmountable obstacles so far as we had gone in their direction but the great trouble was just ahead. So the new line was started. Davis and his party starting at the river and running their line to the eastward, and Hamilton's party starting at the same point and running in the opposite direction for the Soldier pass in the Wasatch mountains. These towered up grim and snow crowned in front of us only six or eight miles away while the Book Cliffs with ragged sides were only a little further away to the right and the valley lay between.

It was dry, hot and dusty, and the water in the river rapidly rising, tearing down from the mountains in a roaring torrent. The graders continued to cross it until several teams and saddle horses were swept away to death in its raging waters. From that time forth the ford was known as Dead Horse crossing. Close to the river there was an abundance of sage brush, greasewood, and rabbit brush growing. The latter we gathered for beds. It has a small stem with great numbers of long, slim elastic branches. A layer of them a

foot thick was as good as a spring bed. Farther away from the river all was dry and barren and almost the only green thing growing was the cactus plants. They covered the ground in irregular patches for miles. A few weeks later all these cactus plants were in bloom and then the desert did indeed blossom like the rose. The blossoms look much like large double roses. Many were of a beautiful bright yellow color, others violet, scarlet, pink and all imaginable tints or shades between. It was a glorious sight to see the broad desert decked out in such gorgeous array. Along the stream and in the mountain glens, other most beautiful flowers were growing, such as I had never seen before. There were dandelions whose leaves and blossoms looked like those at home, but the flowers instead of growing singly on a hollow stalk grew by the dozens on a branching stem. These and some wild sunflowers, and later in the season the wild asters, were the only flowers that bore a familiar look. Animal life was not abundant. Little lizzards like Michigan swifts were plenty and ran in and out of the tents without fear of molestation. They would come in and climb up on a box or perhaps upon your knee and peer curiously around. If a fly was near they went for him. Sometimes one would climb to the very peak of the tent on the inside and making a sudden spring catch a fly as he came down to the ground. They did not seem to mind the fall but would scamper up again and repeat the operation. They were gentle, bright-eyed fearless and harmless little fellows and had the run of the tents for the flies they caught. Here and there the prairie dogs had their mounds thrown up along the road side.

Where an embankment was thrown up by the graders, it just delighted the little fellows to go in and burrow in the soft and yielding earth. Ravens were plenty and buzzards sailed about circling like eagles in the blue sky. Occasionally an old gray headed eagle would look down upon us from a crag as he watched for a jack rabbit or a "cotton tail." In some places we saw flocks of blue jays that uttered notes like short ringing whistles entirely different from the note of our Michigan blue jay. There were also a few magpies in the cotton-

woods. They are much like small sized crows, but instead of being all black, have broad white bands on their wings which make a very showy appearance when they fly. Flies were plenty and troublesome and occasionally a scorpion would put in an appearance.

I staid a little more than a week in camp at Dead Horse crossing and then moved up the line about six miles to the foot of the mountains at the mouth of the upper canon of the Price river.

Hard work and long walks were now the order of the day as half a thousand teams and men were busy piling up the earth and rocks to make the road.

As I have said, the contractors were assigned a half mile or mile each, according to the force they had. As all were ready to go to work at once, and impatient of delay, I had to hustle to lay out work for them. The most of the work was light scraper work, which the men would grade very rapidly. I would go to the end of a man's contract or assignment, cross-section a few hundred feet, picking up my levels from the nearest bench. This done, I would cross-section as much more in the opposite direction on another man's job, then skip away to another place and do likewise. The benches were about a half a mile apart. Presently two of the parties, working in opposite directions met and the grading did not match into more than a foot. I was sent for, and went to see what was the matter. I picked up my level at the nearest bench and tested my stakes up to the point of junction and they were all right. I continued them beyond and they were all wrong. When I got to the next bench, *that* was wrong too. I tested my level to find if it was in adjustment and found it correct. The question now was which bench was wrong. Before I had time to find out I was called two miles away to lay out work for other parties. It happened that a junction was to be made at this point also, so I connected my levels between the opposite benches and found another just such discrepancy. Hamilton's locating party was ahead of me getting out of the way of the graders as fast as the could, and sending me profiles of the line every

day or two, as fast as they made them. They had been in such haste that they had not run a check level and I was so crowded that I had no time to do it either. But now it had to be done and I held the contractors while I went back and ran six miles of check levels. I found a pretty uniform error of about two feet to the mile all in one direction indicating that the locating level was out of adjustment. I immediately sent for the leveler to come back and correct his levels from the point where I had brought them up to. This he proceeded to do while I readjusted the grades on the work already done and had it graded over again, but as I went ahead I found the same trouble continued. The line was climbing the valley with grades running from .5 to 2.5 per cent. The leveler in the locating party was evidently taking long backsights and short foresights right along, and his level was evidently out of adjustment. Repeated notices failing to remedy the disorder I went in person to see about it. Nobody in the party could tell what the trouble was and they had done their best in the way of adjusting the instrument. It was a fine Heller & Brightly level. A few minutes inspection showed me where the trouble was. One of the clips that holds the telescope in the wye had a pin in it which fitted into a notch in a band around the telescope to hold it in position and prevent revolving in the Y's when the clip was fastened. This notch was not deep enough, so when the clip was shut and drawn down to place by the fastening pin, the telescope was sprung out of shape by the pressure of the pin in the notch. Half a minutes work with a rat tail file remedied a defect which had cost the company and contractors ten times more than all the Heller & Brightly instruments on the line were worth. The defective instrument should not be charged with all the blame. The company was just as much to blame for crowding their engineers so fast that they had no time to do good work. The location was a difficult one, and Hamilton's party had to hustle to keep out of the way of the graders. Hamilton's judgment in location was bad at the best, but if it had been ever so good he could not have made a good location under the circumstances. I saw numberless

places where by slight changes in the line I could greatly improve it. I asked Major Hurd's permission to do this and was sat down upon very hard for my presumption. As a result the whole line along there had to be relocated and mile after mile of finished grade was thrown away. Never was the adage that "haste makes waste" more fully exemplified than in the location and construction of the road. The work was being done by that wheel within a wheel, a construction company who were making a profit of from \$5000 to \$20,000 per mile on the work and it was no great object to them to shorten the line.

By the first of July the grading on my first division was done, and I was ordered further up the canyon, to take charge of another. We got a team of one of the contractors and moved on up the canyon, following sometimes along the grade, and sometimes swinging a half a mile away to go around a wash that we could not cross. We crossed back and forth over the river which had now fallen, so that there is less danger in stemming its whirling torrent. The river is closely hemmed in by the jagged mountains, which rise higher and higher as you ascend the stream. Steamboat point is six miles away, but it does not look to be more than one. We follow the line of stakes almost to the foot of its immense vertical walls, with the parti-colored starta of rocks stretching away like immense ribbons, in the broad sunlight, and then swinging round it to the left, the grand old mountain takes on at once a form of most marvelous beauty. The varied colored rocks now take the form of some immense buildings of state, with ornamented cornices, porticos, battlements, friezes, statuary and above all rises the immense pillar which had been our land mark so many miles away.

The top is so much larger than the base, that it seems as though the first storm must topple it over, but there it stands, and just below it are others like it, resting against the mountain side, where they have apparently slid down from their former vantage ground.

The canyon closes in beyond. Eight miles brings us to Willow Creek, where the last of the graders are encamped.

It is terribly wild and rugged here, and we can go no further with the team.

Here and there we see a black looking stratum of rock, with a hole piercing it, and a loose pile of earth and rubbish scattered down the mountain side from the hole. There are little monuments built up to loose flat stones, and beside them a little piece of board stuck up with a paper tacked on it. Coal has been found and those holes are the work of the prospectors, and those papers the notices of their claims.

We wait at Willow Creek till we can get a pack train of burros to take us through the canyon, eight miles further, to Horse Creek. The line is not all located yet, and no train has ever been through the canyon, and only a foot path made by the engineer's party, who passed through it.

After a delay of a couple of days the burros came, goods are packed and we are off again, clambering along the steep mountain sides, crossing the river on logs that the engineers had felled across the streams, and scrambling through the dwarf oak brush that obstructed the way on every hand. The stiff hard bushes tear the sacks in which our provisions are stored, and beans and dried apples are scattered along the road, as the burros force their way through the grubs. I have a cook now in my party, and a square four-holed cook-stove made of sheet iron. The stove catches on the bushes and occasionally the burro takes a run with it, till it is battered almost past recognition.

And now just before sunset, we have come to the end of the canyon. An immense wall of rock stands right across the way, and bars our further progress. But no, the river has found the way around it, and so do we, but we pause in awe as we look at the immense rock "The Castle Gate." It is over 450 feet high, nearly 1000 feet long, and only twenty or thirty feet wide, and stands there buttressed against the mountain on the one side and swinging out across the valley like a gate, to bar the traveler's way. It is well named "Castle Gate." It seems almost impossible, that so thin a mass of rock should stand at such a height, looking as though a breath of wind would bring it crashing into the valley.

We encamped for the night a short distance up the valley from this point, with Boutelle, the locating engineer. Leaving my party next morning to get along with the pack train the best way they could, I went on alone to select a camping place. From here on there was no valley, only the river rushing along at the foot of high mountains which sloped to the very water edge. The dwarf oaks and service berry bushes were thick, and a more plentiful growth of firs, cedars, and red pine made its appearance. Occasionally near the river there was a large pine tree standing with the bark all torn from it for a distance of six or eight feet from the ground, and in the solid wood were rows of scratches a quarter of an inch deep, where the grizzlies or mountain lions had used the tree for a scratching post. It was only a few days before that Boutelle's party had received a friendly visit from a large bear, and I kept a good look out for him as I went along. About noon I came to a spot where the valley widened out, making a little plateau of an acre or so, on which was growing a beautiful grove of red pine, firs and cedars. It was the first grove of large timber I had seen in Utah, and the finest one I saw while there. Here I determined to pitch my camp, near the mouth of Horse Creek. It was near night before the pack train got there, and more than one of the luckless burros had caught a roll with his pack down the mountain side. One of them which carried my clothes, bedding, etc., in passing round an over hanging rock, hit his pack against the rock and was rolled down some 200 feet into the river below. He struck in a pool and floated to a shallow place, whence he scrambled out and took his place in the train again, none the worse for the tumble. I pitched my tent in a little grassy glade among the evergreens with just room for a walk between it and the river. The river was low and went rushing along, its turbid waters flecked with bits of foam and dancing bubbles which overleaped and skipped around the boulders which broke the stream in a hundred whirling eddies. Now and then, a stick came floating down, performing strange antics as it tumbled over one and another of the little cascades which followed each other in rapid succession. When the

sun above the mountatn tops peeped down through the branches of the grove, and lighted up the shimmering waters of the stream, it was a beautiful though lonely spot. But when the night fell down around and nothing could be seen, but the dim outlines of those grim old mountain peaks against the sky, and the gentle moaning of the wind in the tops of the pines mingling with the swashing of the river, was broken by the piercing wail of the catamount, it seemed almost terrible in its loneliness. Then too there was something terribly monotonous in the everlasting rush and roar of the river. Day and night, forever its perpetual roar filled and pervaded everything with its sound till it sometimes seemed as if I could endure it no longer.

The pack train departed as soon as the goods were unloaded, and we were left alone till such time as the contractors could reach this part of the line. A wagon road had to be made and it was several weeks before the first outfit reached the ground. In the meantime we were busy changing the line in places and sticking stakes for the men when they should arrive. It was only a four mile division but was the worst one in the canon. I had plenty of time to study it and get ready for the workmen. During this interval the Chief Engineer and the General Superintendent of construction made me a call. I took them over the line, pointed out places where it could be improved, related my experience on the former division and asked for authority to make changes in the location. As a result, I was told to use my own judgment and change the line wherever I could improve it. This I immediately proceeded to do. Bear in mind this was a narrow gauge road and in the canon work sharp curves were a necessity. 20° curves were the limit and plenty of them were used. The first use I made of my authority, was to substitute a tangent in place of an 18° reverse curve, at the same time reducing the amount of earthwork. It was two weeks before the first contractor got on the ground with his force and the rest soon followed, and then the mountains rang with the sound of the exploding blasts. One party was at work directly across the stream from my camp, and at noon and

tea time we were kept on the watch to avoid the flying rocks. They threw many a shower of dirt and small fragments of rock into the camp, and once a rock as big as a bushel basket came sailing over among us. Of course we always had warning and got behind a rock or a big tree if we saw anything dangerous coming. It was the 4th of July when I took charge of the work on this division, and the picking and scraping and blasting and shoveling went merrily on till the middle of August, when I got orders to turn over the work on this division to another engineer and go to Clear Creek and take charge of the work on the west slope of the mountains. This was considered the best position on the line, for at Clear Creek were railroad connections with the outside world, and the company had there a store-house well filled with provisions and best of all there the mail came regularly every day.

These were no insignificant items, for in all these six months past, we never got our mail oftener than once a week and then much of it was old. Then, too, since we had been in this camp we had lived at one time on nothing but bread and dried apples for more than a week, and the graders were no better off. You may be sure we set out for our new work with light hearts and we did not walk either, except where we had to. I had walked from Salina through the Salt Creek pass over the mountains, and up the long stretch from end to end of Castle Valley; down the Price River into the canons of the Cedar Mountains, up the Price again by Dead Horse Crossing, Steamboat Point and the Castle Gate through the canons of the Wasatch till here we were at Horse Creek only a mile and a half away from the old Spanish trail and eighteen miles from Soldier Summit. I had tramped hundreds of miles through all that was dreary and desolate and all that was grand and beautiful along the road and now I would have a ride. So I hired a man with a light spring wagon to take us over to our new camp. About four miles down the western slope, we came to a spring of beautiful clear cold water, not far from a mountain brook "the Soldier Fork" and here we pitched our camp for the rest of the summer. Evening was coming on and before we went to rest we heard for the first time

in half a year the shrill whistle of the locomotive as it rolled into Clear Creek station three miles below us.

Next day I went down to Clear Creek station and saw Eaton, the engineer, who had located that portion of the line between the station and Soldier Summit. He was encamped about a mile from the station. He had ran a great number of lines between the two points and the stakes were sticking around in all directions. The contractors were on the ground and at work in various places along the line. Half of Eaton's party had been sent away and only enough men were kept with him to stake out a little work for the contractors till I came.

That same day the chief engineer came out and after looking over the line decided that a new one must be located. So our two parties were joined and together we made the location. We got a reasonably straight line but the road had about 1,400 feet fall in seven miles from the summit.

All through the country the scenery changed with the geological formation. On the western slope it differed greatly from the eastern. The mountain sides though very steep did not present the rugged, vertical cliffs and jagged outlines of the eastern side. On this slope we were within the Salt Lake basin, and the rocks were many of them filled with fossils in various degrees of petrification. And then there was one stratum of rock extending the whole length of the valley of the Soldier Fork along which we were working, and I don't know how much further, that was a curiosity of itself. I called it a stratum of rock. Perhaps formation would be a better word, for it was made up of a great many very thin strata, a quarter of an inch or less thick, the whole making up a mass of from six to fifty feet in thickness. From twenty to fifty feet per cent of this rock consisted of a dark colored wax very much resembling parafine in its consistency, and looking like shoemaker's heel ball.

This wax was easily separated from the rock by simply heating it in a vessel over the fire, when the wax would rise to the surface, and the earthy portions of the rock settle to the bottom. Covington the hotel keeper at Clear Creek, boiled

out a thousand pounds or more of this wax hoping to sell it at a profit, with what success I never heard. We sometimes built a little fire of dry wood and then piled on sheets of this rock which then burned freely with an odor resembling kerosene.

This rock now promises to be of great value for paving purposes, being simply crushed and used as we would gravel. It is said to make an asphalt pavement without its slipperiness.

The line on this division had a continuous fall of 3.8% with only one break in the entire distance. There were not very many curves sharper than 10° and on all the curves the grade was flattened at the rate of .04 feet for each degree of curvature. The latter part of September snow began to fall, first in the mountain tops and gradually working down into the valley.

By the second week in November our work was completed in this division and there we lay in camp with nothing to do. The graders were all gone except a small party at the summit and it seemed lonely enough. One day I got a telegram to meet some men at Clear Creek the next morning and I would there find orders. I was there when the train came in and found directions to go with a party of men up to the end of the Pleasant Valley railroad and hunt up some coal claims and set these men at work on them. I was given a rude sketch of the country to find them by.

This was an opportunity I had been wanting for some time to see the country up the line of this road. It is a narrow guage road built to bring down coal from the Pleasant Valley mine. No passenger trains run on the road and only two freight trains. One of these takes a way-car up to the mine and the other leaves its way-car at Clear Creek, twenty miles below, so as not to draw any extra weight up the mountain. Ten empty cars make the load up the mountain. Ten loaded cars are as many as one engine can control coming down the mountain.

From Clear Creek we went winding along a narrow tortuous canyon, crossing and re-crossing the little stream which

ran at its bottom, for a distance of about six miles. There was a station house there. Just beyond it the canyon parted into three branches and the road seemed to come to an abrupt end in one of the most romantic and wildly beautiful bits of mountain scenery that I ever beheld. This is the "lower back switch." The road can no longer follow the steep rise of the canyon. The train runs out to the end of the track, a switch is turned and we go backwards on the side track. As we go we climb higher and higher up the mountain side and gradually draw away from the track that we came up till now we have been backing two miles and the other track is more than 500 feet below us and a quarter of a mile away. But now we swing with a sharp curve around the end of the mountain and so winding and climbing, with the way-car ahead and the engine behind, we go for nearly five miles, when we come to the end of the road again, or rather, to the "upper back switch." We look about us and find we have got nearly to the top of the range and as we glance down a canyon which opens before us we see a thousand feet below and about a half a mile away the "lower back switch" that we left an hour ago. We double in our track again, this time with the engine ahead, toiling slowly up the mountain side till we reach the summit where there is a pile of telegraph poles and ties that have been hauled from the neighboring ravines. There is a little station house here, too, for the track men. We make a brief halt here and soon are speeding rapidly down into Pleasant Valley.

This is the most beautiful, homelike spot I saw in Utah. A valley nestled among the mountains nearly 8,000 feet above the sea with grass growing almost thick enough to make a turf, and flocks of sheep and herds of cattle grazing at will or gathered in corrals near the ranchman's huts. The valley is four or five miles long and from one to two miles wide and looks as level as a prairie. The soil is dark and rich and would produce splendid crops of anything if it did not lie so near the clouds. But the nights are cold and frosts come every month in the year, so it is used for a summer pasture and when the winter comes the flocks go to a warmer climate.

Fish Creek runs the length of the valley, then making a sudden turn, dashes through a deep canyon down to the Price River. It is noted for the number and size of the trout which are found in its waters.

We soon cross Fish Creek and then the road begins to climb again till we reach the upper end of the valley where we get off the train at a little village made up of a boarding house, a store, and a big pile of ties. The train goes on and dashes into the gloomy recesses of a dark canyon and in five minutes more we hear it whistling at the mine a mile away.

Next day we spent wandering about the mountains, now following up some dark canyon, now clambering over some craggy peak, searching here and there for the work of the prospectors. We ask no questions and tell nobody our business, for do you know, we were there intent on jumping claims. Rich and valuable coal deposits were known to exist there. The prospectors had been there several years before and picked and dug their holes here and there in all manner of out-of-the-way places, and built their little log pens which they called their cabins, and made their claims. But something new attracted them elsewhere and they failed to prove up their claim and get their title within the time prescribed by law. Now a railroad was opened within easy reach of them, owned by the Denver & Rio Grande. The Union Pacific was building another right beside it to reach the same field and now these claims were of some consequence and the first ones to get possession of them were the best fellows. We got there. It was a hard tramp over half a township, with the snow about six inches deep and melting in the sun, but in the course of two days I found all the claims, eight in number, and had men at work on them.

Next morning I asked the boarding house keeper if the train would stop for me on signal, or must I go up to the mine. He said they would stop for me, so I stood on the track and waited till they came in sight out of the mouth of the canyon, and waved my handkerchief as a signal. But the train went by me like the wind, only a single car loaded with coal being cut off from the rest of the train and stopping

there. I supposed I was left, but the brakeman on the car shouted to me to hurry up and jump on. Without stopping to ask any questions I climbed up among the coal and found as comfortable a place as I could and then followed *the* railroad ride of my life.

The train was already a mile away speeding down the valley when the brakeman loosened the brakes and our car began to move. At first the motion was slow, but with each turn of the wheels we went faster and faster, the brakeman keeping it well under control till we struck a long straight line down the Pleasant Valley and then we fairly flew. It was snowing and a chilly wind beat the hard snow flakes into our faces. I crammed my hat down tightly on my head, but it would not stay there and I had to hold it on, which was inconvenient as I needed more hands than I had to keep my position on the car. The train steams on ahead and we follow like the wind rapidly lessening the space between us till just before we reach the rear end of the train the brakeman, who is at the front end of the car, puts on the brakes with all force and we glide gently up and the car is coupled on without the least jar or slackening in the motion of the train. I may have rode faster than I did on that car, but I never rode in any place that gave such a thrilling sensation of flying at whirlwind speed through the air as then. It took the train three hours to go from Clear Creek to Pleasant Valley, but the return was made in one hour.

One day about the middle of November a telegram was brought to my camp with orders from the chief engineer directing me to go to Clear Creek and take charge of a party which I would find awaiting me there. When I got there I found a large locating party in camp about a mile up the Utah & Pleasant Valley railroad from the station.

The Denver & Rio Grande railroad company had got possession of this road some months before, and were now operating it. I was to make a re-survey of the line of the road with maps and profiles to show its location and grade from Clear Creek to the Pleasant Valley coal mines. The weather was cold, but not so uncomfortable as one might

have expected from the indications of the thermometer. There was a little snow on the ground along the valley, and a good deal more in the gulches and ravines along the mountain sides to the summit. We moved camp from place to place along the line by loading our things on the passing trains which took us up and let us off wherever we chose. When half way up the mountains, part of the men gave out with the cold and left me. In their place a couple of Michigan boys, McIntyre and Rockwood from Flint, were sent to my party. They came just as we were running our line over the summit, and down into Pleasant Valley. It was biting cold there, with the wind blowing and the mercury down to 20° below zero, when we would start for our work in the morning. It was not a week till we had our line run up to the very mouth of the coal mine.

The original location of this road could hardly have been made by an engineer, or if it was it must have been built regardless of location. There were two switch backs on the line, the curves very sharp and irregular and the steepest grades were on the sharpest curves. We frequently found four per cent grades on 30° curves with 2.5% grades on tangents between. In retracing the line, the stations were simply marked with chalk on the rail. The transit man only set up his instrument at the points of curve and tangent. He used two rodmen—one at the head of the chain who only used the rod on curves. If the curve was a long compound the rod was set up in the middle of the track at each station and the deflections read off from the transit. These deflections would show some where near where the P. C. C's. would occur and the transit was set in these points as near as could be found. On the shorter curves, whenever it was possible to do so, the P. I. was located, the angle of intersection taken and the tangents and external secants measured to determine the amount of and degree of curvature. In such cases the curve itself was not run with the transit.

Our work here was soon done, and we returned to Clear Creek and went into camp to await further orders. It was a matter of a good deal of speculation among the boys, as to

what would be done with the party. Would we be discharged as so many of the parties had already been, or would we be sent over the mountains into the lower canyons of the Price, which Davis had been recently exploring. The latter seemed a desperate alternative to some of the boys as winter was now upon us, and the snow was daily piling up higher and deeper over the summit. It was an open question whether we should be able to get any provisions over the mountains into that country after we got there. Our cook and all the Mormon boys in the party but one, left us, from very fear of being sent there. We supplied the cook's place with a heathen Chinee, who stayed with us and cooked our victuals, and stole our provisions as long as we stayed at Clear Creek. It was not long till the dreaded order came for us to break camp and start for the lower Price. John Chinaman would not risk himself on the other side of the mountains, so we were obliged to start out without him. It was the sixth of December that we broke camp and started for our new work, one wagon drawn by a span of mules, carried our tents and baggage and hay, and grain for the animals. Another wagon loaded down with provisions, made a load for four more mules. We had flour, beans, bacon, hams, baking powder, dried apples, canned tomatoes, butter and a general assortment of spices and condiments. We expected to get fresh beef and mutton when we got there. We started without a cook, and with only half a party.

It was a clear, pleasant Sunday afternoon when the boys started out from Clear Creek. A little snow had fallen the night before, in the valley, and was now thawing, so that the roads were as slippery with soft clay mud, as if they had been soaped. The wagons were loaded as full as the teams could draw, and the boys walked along side, giving a lift now and then up some steep pitch, or holding the wagons from slewing around and tipping over when they ran over a piece of sidling ground. I stayed in Clear Creek to have a short visit with my brother, who had just come over the mountains on his way home.

Next morning I started out on foot and alone, to overtake

the party. Snow had fallen during the night and as I neared the summit it grew deeper and deeper, making the walking very difficult. Half way up I passed a dozen teams belonging to the company, loaded with hay, grain and provisions, which they were trying to get over the mountains before the road became impassible. I overtook the party a little after noon, a few miles over the summit at Marion's camp. From here on the roads were better for some miles, and we trudged merrily on, now and then mounting the wagons for a ride when the road would admit of it.

We were following the old Spanish trail, which leaves the valley of the Price river near the mouth of Fish creek, and avoiding the canyon, passes to the left through Emma Park. We camped that night at the foot of Coyune Hill. We have thus far kept along a broad open valley between two mountain ridges, the river all the time running near. The valley continues on and the trail follows it, but the Price makes a sudden bend to the right, and makes its way through the very heart of the mountain range, and we see no more of it for the next fifty miles. The next day at noon we reached Horse Creek and I took the opportunity to run down it to my old camp on the river, among the firs, where Davis was now settled. The telegraph wires had reached the camp, and an operator sat at his instrument communicating with the outside world. Davis was away down the river, and after dinner I rejoined my party. Night found us at Elliott and Davidson's sheep ranch in Emma Park. There was a log hut beside a little stream and a large corral of an acre or more divided up into several smaller yards filled with sheep. When we had pitched our tents and eaten our supper, and turned out in the dark, a scene met our eyes which would have filled the heart of any artist. There were the gloomy snow capped mountains with the stars peeping out over them for a back-ground, at their foot was the level park with its hut and corrals all lighted by the lurid blaze of a fire, over which a large caldron seethed and boiled. Beside it was a large vat, and half a dozen men in rough costumes engaged, some in dipping the decoction to and from the caldron and

vat, others were catching sheep from the adjacent pen and plunging them over head and ears in the vat, and others standing ready and pulling them out on the other side. Half a dozen dogs were playing about and seemed to take as much interest in the work as the men themselves. The sheep which had been feeding in the mountains were now gathered together in the park and were being dipped in hot lime and sulphur water as a remedy and preventative of scab before being sent into Castle valley for the winter.

Elliott was said to be the son of an English lord, and his partner, Davidson, was a Scotchman. They had been in India and Australia, and finally settled in this uninhabited portion of Utah for their stock range. They owned about 30,000 sheep, and a relative named McLaren had about 15,000 more. We had met them on our first trip into the Castle valley in the spring, and had found them to be gentlemanly, well informed men. We frequently met their shepherds further on, who had standing orders to furnish our party with mutton free of charge, whenever we asked for it.

Next day we entered Soldier canyon. The road was very rough and had been washed away in places, and it required the constant assistance of the party to keep the wagons from overturning. At one place I took my rifle and went ahead of the party in hopes of finding some game. A dead sheep laid on the ice in the creek which something had been at work at and which I must have disturbed. I sat down behind a tree to watch a few minutes. Presently a small flock of magpies alighted on the sheep, and began to tear and devour it. I fired among them and killed one. As I went to see the result of my shot I noticed a black spot where my ball had struck the opposite bank just at the edge of the ice. Picking into it I discovered a vein of very fine cannel coal. It extended only two inches above the ice and how much below I do not know. I carefully noted the spot but have never been there since.

Just before leaving Soldier canyon the road climbs a very steep hill a couple of hundred feet high. Night caught us at the foot of the hill; next day it took us till nearly noon

to climb the hill, as everything had to be unloaded from the wagons and carried up by hand. When we got there the broad expanse of Castle valley lay like a panorama before us, stretching out for miles and miles away. A hard afternoon's drive which extended well into the night brought us once more to Price river, at the same crossing where we had first struck it and camped in March before.

The spot looked, if possible, more desolate than it did when we were there the spring before. Then there was a shepherd's camp near by with a great flock of sheep grazing on the plain. Now, nothing broke the silence of the desert save our own voices or the sharp bark of the coyote along the foot hills just at set of sun, and every night, long, scattering flocks of ravens passed over in their straggling flight toward the Cedar Mountains. The grim mountain tops on either side were covered deep with snow, but the broad expanse of Castle Valley lay spread out before us as dry and bare as in midsummer. Herds of cattle, almost wild, grazed along the foot hills, and sometime during the day we would see them come trooping down in long files to the river for water. Sometimes we would see a solitary horseman, clad in leather garments galloping over the plain or clambering up the hill-sides or silhouetted against the sky as he sat astride his horse upon some mountain top, still as a statue, and gazing intently through his glass in search of the herds intrusted to his charge. A loose horse without bridle or halter accompanies him bearing a pack in which are blankets, skillets, camp-kettles, flour, baking powder, beef, salt and tea or coffee. With this outfit he rides alone week after week looking after his cattle which are scattered all over the country from the Wasatch mountains to the Green river.

He stops at night wherever he can find wood and water, and grass for his horses, and takes his noon day meal wherever he happens to be. The cattle were in fine order now and made the finest beef I ever ate.

Before leaving Clear Creek I had taken the precaution to procure from Tucker & Thomas a written order on their herdsman for beef whenever we wanted it, and lest we might

not meet him when in need I had permission to kill for myself beef out of their herds on condition of reporting to them the number and kind of cattle I killed. This order was of great use to me afterwards when I got farther down the canyon. There were two parties of engineers in this field, my own and another which was at work above us bringing down the new line from Dead Horse crossing to the old line which I run the spring before by way of the Grassy Trail creek. Parrish's party was already at work on the line down from Dead Horse and in a few days he had his line down to our camp. From this point on he was to follow our old line over the divide to the Grassy Trail creek and thence down the creek to its junction with the Price river.

I was to follow the Price in its windings through the great canyon of the Cedar mountains, to the same point and when the junction was made one party would be sent in, and the other would continue down the river through the Book Cliff canyon till they met a party coming up the river from the east. Whose party would stay and complete the line from the mouth of the Grassy Trail creek on? The work began to look attractive. As we pushed on down the canyon, its walls began to take the most wonderful and attractive forms. The weather was superb. We began to wish that such a job might last forever. "Boys" said I, "we have got the longest and every way the most difficult line to run—which is as great a compliment as the Chief Engineer could pay us. Can we beat those fellows to the junction?" "We'll try it, and they have got to get right up and climb if we don't beat them," was the reply, and away we went.

Our transit had a gradienter attachment which was of great assistance in locating the line and was kept in constant use. I think it saved half the time of the party on a large part of the work. Our preliminary lines were run with the same care as the finished location and all the curves were run in as we went. That was also a great saving in time as the preliminary was used as final location whenever it turned out satisfactory and we went right on with the work. There was a great deal of compounding of curves to do as the line wound

around the base of the mountains. In locating the curves we invariably put in the P. I's. and determined the degree of curvature by measuring the external secant to the point the curve must pass through—if the ground would admit of it. I do not now remember a single instance in which it could not be done. By this means we were enabled to put the curve right where we wanted it the first time trying in nearly every instance. The other party had the advantage of my line run the March before of which the stakes were still standing, but I knew that they made no use of the gradienter and located their curves by the cut-and-try method as did most of the engineers on the road, and I hoped to neutralize their advantages by using better methods and doing more rapid work. I had a transit man said to be the most rapid workman in the company's employ and as soon as I got him well instructed in my methods of working we made rapid progress.

The mountain walls rose higher and higher and more nearly vertical on the side of the valley as we worked further toward the heart of the mountain range. The character of the rocks and the scenery was constantly changing. Now it was dull grey sandstone burnt with volcanic fires till its surface was fused and glazed so hard that a cold chisel would hardly mark it, and all scattered about were beautifully colored and highly polished pebbles, so hard that a file would not scratch them. After that the prevailing rock was a kind of pudding stone made up of millions of small pebbles, of various colors, cemented together into a solid mass many hundred feet in thickness. In one place a side canyon opened into the valley near our camp. It was two hundred feet deep and nearly filled for half a mile with boulders of this rock from the size of a barrel to that of a large house, all tumbled in together in dire confusion. The dry bed of a stream lay at its bottom coursing under and around those rocks. I followed it back to its summit, now squeezing between the boulders, now crawling along a dark cave underneath them, and revolver in hand keeping a good look out for any bear or mountain lion which might be lurking

there. It was a wild, toilsome, exciting trip and I was heartily glad when, after an hour's hard labor, I found myself standing on the summit of the mountain with all the crags and rocks below spread out before me. We called it the Thunder-bolt canyon. Near by was the great stone elephant—the most remarkable natural curiosity I saw in the West. We camped beside it for over a week. It was a great rock jutting out from the base of the mountain into the valley and worn by the elements into almost the exact form of an immense elephant. It was of the same conglomerate rock I have mentioned, and had the form of trunk, head, eyes, ears, forelegs and body nearly as perfect as if chiseled by the hand of a sculptor. No aid whatever is required from the imagination to see the resemblance, and it makes not the least difference from what direction it is viewed, no one could mistake it. Right back of it rises a tall mountain peak. On Christmas day we all climbed the peak and built a tall monument of loose flat rocks upon its highest point. In it we placed a record of the party and the date, and chiseling the name upon the topmost rock we called the mountain Christmas Peak. A few miles further on we left the conglomerate and entered a region where the prevailing rocks are of sandstone of various colors, mostly of a very delicate purplish tint of grey when freshly broken, but assuming a bright red color after exposure. We first found them at the "Ribbon Rocks," where a cliff juts out into the valley with vertical sides, and the upper strata projecting like a cornice and made up of horizontal layers of alternately red and yellow rock, whose bright colors resembled streamers of parti-colored ribbons floating in the air. Further on, the walls of the canyon took on architectural forms and for a distance of six miles resembled the pictures I have seen of ancient cities, only no work of man's hand was ever so beautiful and grand. We called it the Eternal City. The canyon of the Price made the principal street while side canyons coming in at short intervals, on either side, resembled the cross streets of a city. The whole valley seemed lined with great buildings of a brick red color, with columns, porticoes, cornices, balconies and towers in

almost inconceivable variety and beauty, and sublime in the grandeur of their vast proportions. One of these rocks was about 100 feet wide, 300 long, and from 150 to 200 feet high. It stood out entirely separate from the mountain, across the mouth of a large side canyon. Its walls were either vertical or overhanging and unless one had a balloon or a ladder more than a hundred feet long its summit could not be reached. It looked like some great bank building. On the side toward the mountain was a series of hieroglyphic markings done with some kind of paint. They resembled a series of pillars connected with arches, eight in number and all connected by one large arch sweeping over the top of all. They were at least sixty feet above the ground, inaccessible from below and where the rock overhung so much that if a man had hung down by a rope from the top he would have swung at least a dozen feet away from the markings. How came they there? I explored the side canyon back of this rock for a long distance and found the rocks marked in a great many places in a similar manner. It was evidently done with some kind of paint and being always under the overhanging rock where it is perfectly dry and sheltered from both sun and storm it has lasted for nobody knows how long.

The first morning after we camped there as we went out to work we found in the path we had made the day before the fresh track of a mountain lion. It was like any cat track only so large that when I stooped down to measure it with my hand, the hand would not cover more than two-thirds of the track. It was as large as the largest horse track I ever saw. We never met the fellow who made it, though we would have been glad to have got a sight of him at a safe distance. Bears, mountain lions and lynxes were plenty in that region, and it was a little remarkable that although I was out alone a great deal of the time prospecting along the line and among the mountains I never happened to meet one of these animals. I always went armed and prepared either to fight or run away, as the case demanded, if I should meet one of these fellows.

It was late in December and our party had worked their

way well down into the Cedar Mesa Canyon. We had thus far worked with short numbers. We had no cook and I had been obliged to detail McNulty, the young California tramp,* who knew how to make biscuit, to do the cooking. We did not fare very well.

We had no topographer, and there was urgent need of such a man. In addition to my own duties I was obliged to take the topography so far as time would permit. When I took charge of the party I found an aristocratic young man from New York City, by the name of Suydam, filling that position. He was away in Salt Lake City when we left Clear Creek but came to us at our first camp on the Price river. He stayed a week when the country got too rough for him and he went back to the City of the Saints.

On Christmas night a pack train with a dozen mules and three horses reached my camp. We had got beyond the reach of wagons and they had come to stay. With the animals were Ed Baker and Jack the packers, and Jack Hilz, a cook. With fresh supplies and a cook, we began to think we should live a little better, and we did. When we were out of meat I gave Baker my rifle and started him out after one of Tucker & Thomas's cattle. In due time he returned with the quarters of a young beef and then we lived on the fat of the land. Sometimes we got mutton from Elliott & Davidson's, shepherds who were not far away. When one beef was gone Baker got another one from the mountains. One day a man clad in leather with a pair of navy revolvers hanging in his belt came along making inquiries in regard to the cattle we had been killing. It was one of the Whittemore's, who owned herds of cattle and horses roaming in that vicinity. He evidently seemed to labor under the impression that we had no business shooting people's cattle down whenever we took a notion to do so. I showed him Tucker & Thomas's order and description of brand.

"But," said he, "Tucker & Thomas have no cattle within fifty miles of here, and besides, there are three of us who have cattle branded in that way with a T—myself, Tucker & Thomas and Terry. The cattle you have killed must be either mine or Terry's."

"I know nothing about that. You see my order. I have killed only such cattle as it describes. If they are yours you have only to satisfy me on that point and your pay is ready. We are here over the mountain in the dead of winter, more than a hundred miles from our supplies. You are the first cattle-man we have seen and we have not the slightest intention of going hungry when there is good beef handy by."

"Well, you are all right. But after this let me know when you want a beef and I will bring it to you. I had rather do it than have you shooting mine. My camp is about twenty five miles below here in the direction you are going and I shall see you every few days."

That order saved me a row with the cow boys. I saw Whittemore frequently after that and he sometimes stayed with us over night. We did not have to go hunting after beef any more.

One night after we had got down into the "Eternal City" three men came into our camp from over the mountain. One was C. B. Collingwood, a boy from the Michigan Agricultural College, who had been with me a month or two while I was in charge of the construction at Clear Creek. He came as topographer. With him were three men who came as common hands. They had left Benton Camp, on the Grassy Trail Creek about noon, and were till nine o'clock getting seven miles over the mountains and down into the canyon. They had rolled their blankets and packs down the precipice into the valley and barely escaped rolling themselves over the same cliffs in the dark. It took most of the next day to gather up the scattered articles. The wonderful cliffs and battlements of the Eternal City extend about seven miles down the river, a city not made with hands.

In one place an immense dome of rock rises up from a base which at a little distance looks like some great building. The dome rises at least a hundred and fifty feet above its base and when when we first saw it at a distance of about four miles, the whole looked so much like the capitol at Washington that we instinctively named it Capitol Rock.

The river swept close around its base so that it formed a

sort of peninsula jutting out from the mountain-side into the valley. At what we might call the isthmus the rocks were comparatively low so that it seemed an easy task to climb them. Our line ran right at the foot of this rock and we passed it daily for several days as we went to and fro between our work and camp.

With the additional help we were now making good progress. We occasionally heard from the party on the other route and were evidently gaining on them. Every man felt that if we could only beat them to the junction in spite of the disadvantage in distance and character of the country, it would be a great feather in our caps. And then the work was one glorious holiday picnic and we all wanted to stay till it was finished. The weather was the finest possible for our work and the ever changing scenery of the canyon grand beyond description. Wishing to preserve mementoes of it, I sent for a photographic camera and outfit to take views of the finest points of the scenery. It came so late that I missed getting views of many of the finest points, and my photographing was not a success.

One morning about ten o'clock, our line reached the Grassy Trail Junction. We looked up the valley of the creek. Nobody was in sight, neither could we see anybody down the river. We looked for stakes, but found none save those of my own line run almost a year before. Hurrah! We are ahead, and will go skipping on down the river to meet the party coming up from below, who are not far away. We had run twenty-eight miles of crooked canyon lines to sixteen miles of the other party and got in several days ahead of them.

We continued our line down the river for about two weeks when I received orders to turn over my party to L. M. Davis and report in Salt Lake City.

This was early in February. I had been with the boys since the middle of November, and had become greatly attached to them. No better fellows ever worked in a party together. The parting was a sorry one for all of us. Four of the boys, McIntyre, Crandall, Hiltz and Baker, knowing

that the work was nearly ended, chose to leave the party and go with me to Salt Lake City. We bade the other boys good-bye and started for our lonely tramp of sixty miles to Clear Creek where we would reach the railroads and settlements. As we passed along we took a last look at the scenes so full of interest to us and dear from their associations. At Frank Davis's camp we met the chief engineer, who gave us an outfit, and sent us into the upper canyon of the Price to make a topographical survey of the Willow Creek coal region, and locate coal claims. Our road lay along the grade that I had spent the summer before in building and every stake and curve was familiar. There had been high rains since I was there and the grade showed the effect of them. There were half a dozen places where I left openings for culverts. Major Hurd, the resident engineer, came along and ordered them filled up. The water had torn it way through. "Now, Major, who was right, you or I?" And now Steamboat Point with its Sentinel Rock towers grandly above us and passing round it we enter the grim depths of the upper canyon of the Price. The graders are gone and we hear not the sound of the blasting. The air is cold and the ground covered with snow which grows deeper as we ascend. The river is no longer a raging torrent, but a babbling brook tumbling down the mountain-side. And here Willow Creek empties into the river, and the giant, jagged, storm-worn cliffs tower grandly above. Here and there on their sides are black looking holes with little piles of dirt at their mouths and rattling down the mountain sides. There is where the prospector has been at work in his search for coal. At the foot of one of the cliffs is a little log hut about ten feet square with a dirt roof, one door and no window. The horns of a mountain sheep hang on the end of a log at one corner, and worn out picks and shovels are lying around. The hut is occupied by two miners who are employed by the railroad company to stay there and prospect for coal. We pitch our tent beside the hut and spend the next week in running lines and taking measurements in all directions among these jagged mountains.

A piece of tangent on the grade below the great Castle

Gate is taken as a base and lines are run to all the prominent points and coal outcrops in the vicinity. The measures are all taken with the transit and stadia wires, as the ground is so rough nobody can chain it. When the work is completed, we pack our instruments, and leaving tent and all in charge of the miners, make our way with a passing teamster over the drifting snows of Soldier Summit to Clear Creek where we take the cars, and soon are landed again in Salt Lake City. A week is spent there in making up my maps and report, and then bidding farewell to my comrades and the grand old mountains, I speed my way home again, where I appreciate as I never did before, the worth of a home, family and friends.

~~~~~

**The Fourteenth Annual Meeting of the Society will be held at the City of Indianapolis. Timely notice of the time and the place of holding the session will be given by circular letters and in the press.**

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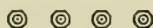
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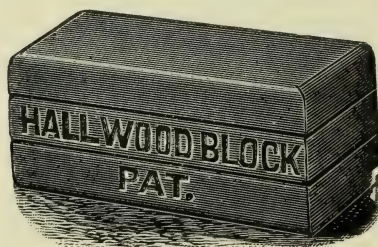
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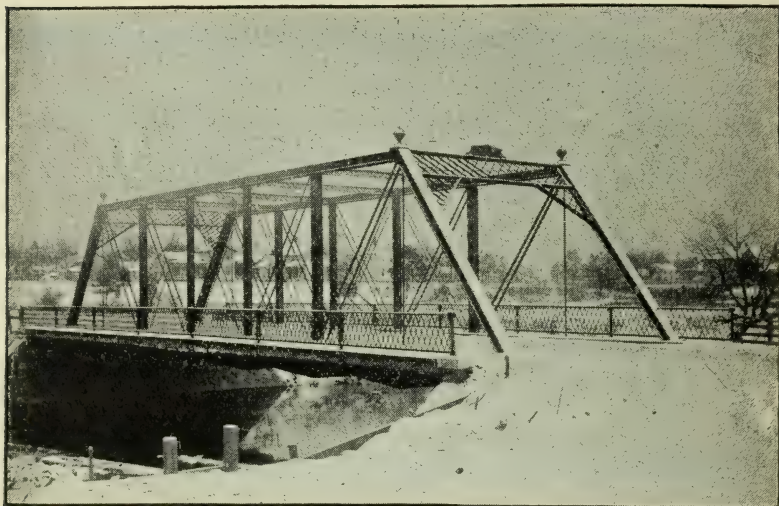
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|                       |           |         |
|-----------------------|-----------|---------|
| Insoluble Matter      | - - - - - | 5.60    |
| Carbonate of Lime     | - - - - - | 47.79   |
| Iron and Alumnia      | - - - - - | 1.40    |
| Carbonate of Magnesia | - - - - - | 42.86   |
| Water and Loss        | - - - - - | 235-100 |

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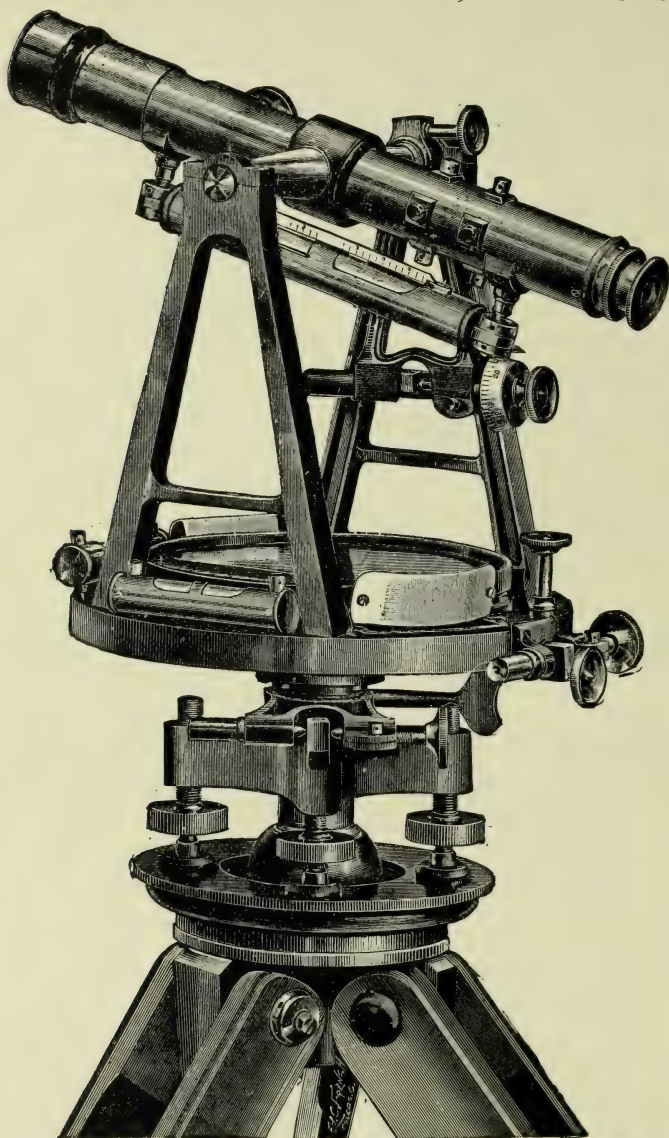
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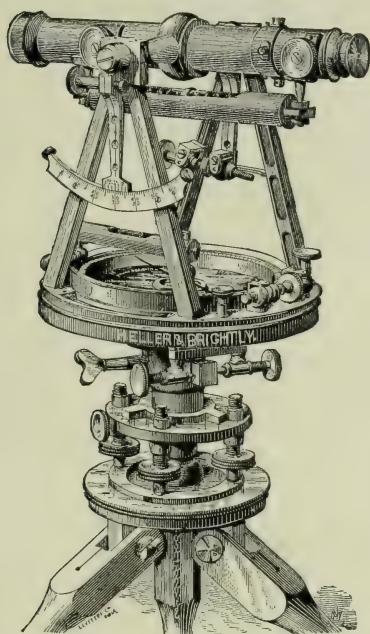


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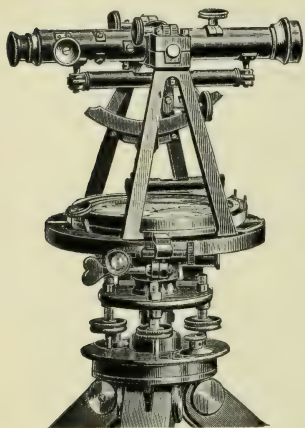


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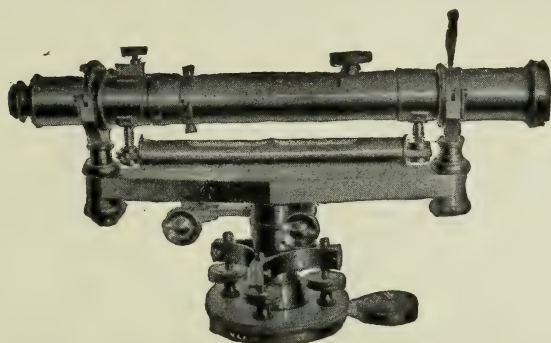
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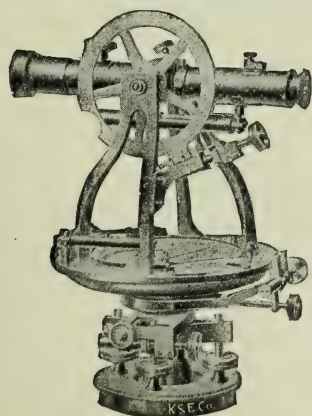
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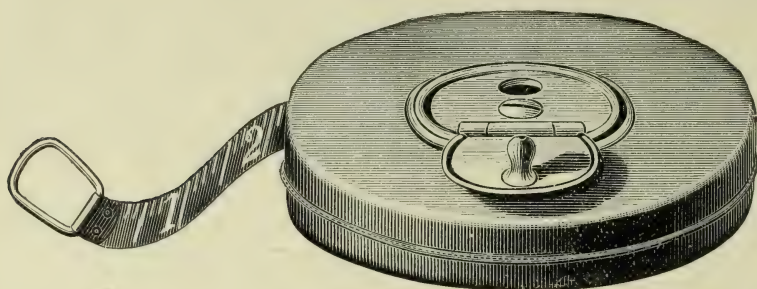
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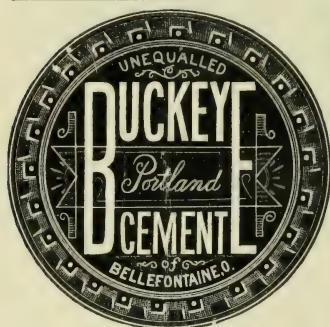


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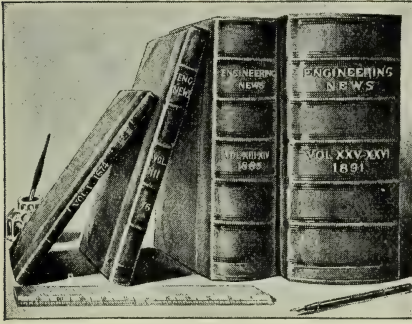
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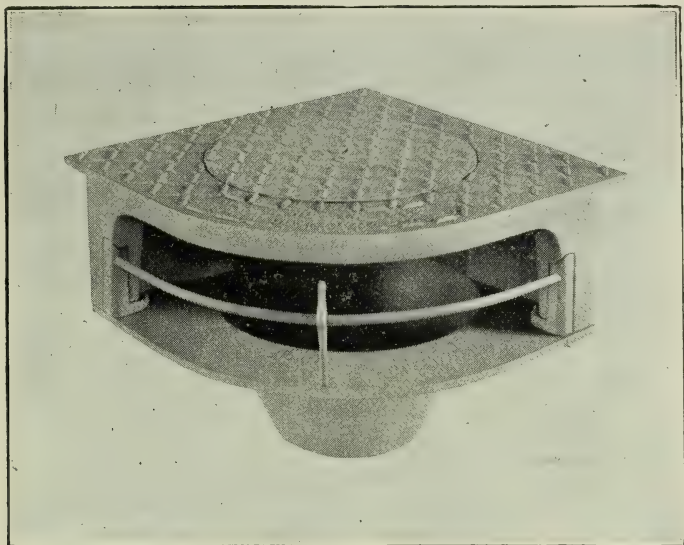
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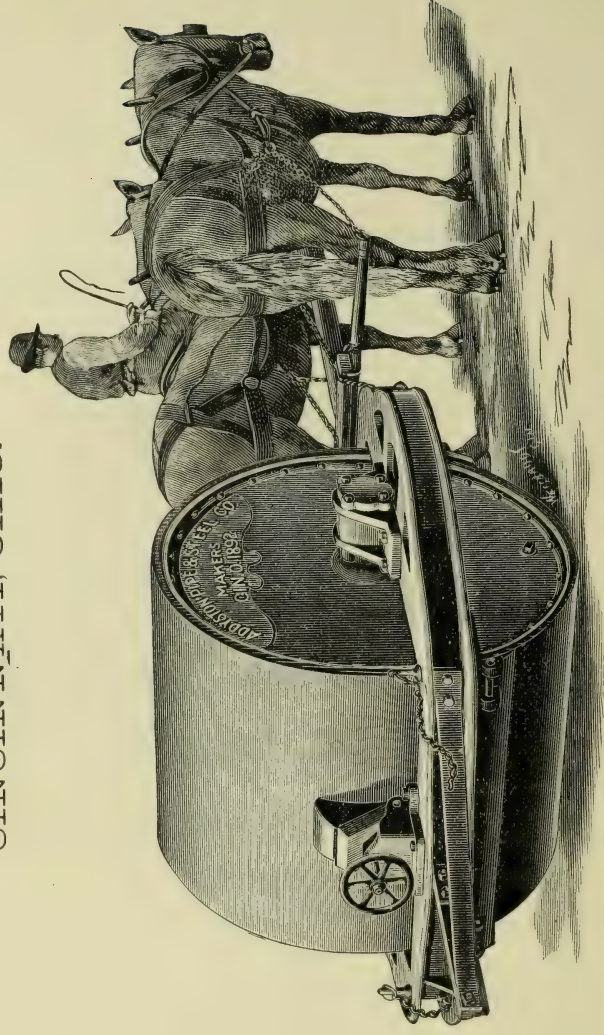
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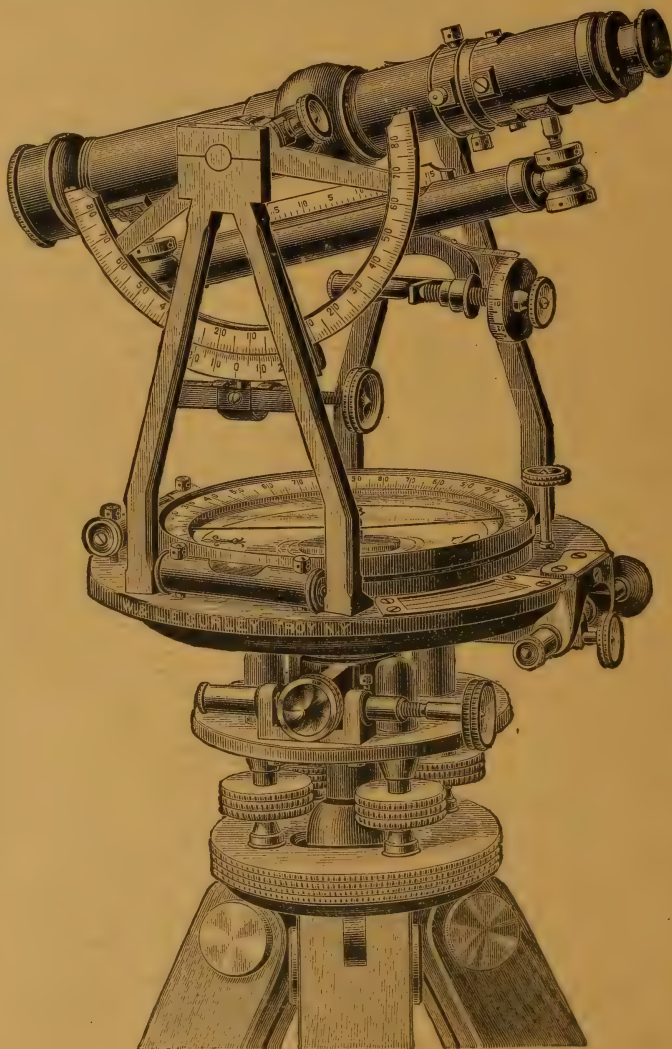
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## Summary of Proceedings.

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INDIANAPOLIS, IND., January 2, 1894.

The Fourteenth Annual Session of the Indiana Engineering Society was convened at 2 P.M., President Whitten in the chair.

Roll call of officers showed the following officers and chairmen of committees to be present :

WM. M. WHITTEN, President.

C. G. H. GOSS, Vice-President.

W. P. CARMICHAEL, Secretary and Treasurer.

R. A. HOWARD, Chairman Committee on Engineering and Surveying.

J. F. MEEGHAN, Chairman Committee on Statistics.

W. P. CARMICHAEL, Chairman Committee on Compiling and Publishing Reports.

The report of the Secretary was deferred to the evening session.

The report of the Committee on Compiling and Publishing the Annual Report was presented by the Secretary, *ex-officio* Chairman of the Committee. On motion of Mr. Morrison, the report was ordered corrected by the omission of the statement that the Malvern Clay Company was delinquent, and the report was adopted and ordered incorporated in the annual report.

President Wm. M. Whitten then read his annual address.

Under the head of Miscellaneous Business, a general talk was indulged in by the members as to blue-prints and methods of reduplicating drawings, and erasures on same.

Mr. Alter moved the appointment of a Committee on Questions and Suggestions, for the reception and presentation of miscellaneous matter. J. E. Alter and L. A. Bostwick were named on the Committee.

On motion of a member, the paper of J. E. Alter, who was on the program for the evening on the Allotment of Ditches for Repairs, was read in Mr. Alter's excellent German dialect. Discussion by L. S. Alter.

Mr. L. S. Alter announced that Hiram Burner had entrusted him with a paper on "Street Construction," for presentation. The paper was substituted for the report of the Drainage Committee on the evening program. Mr. L. A. Bostwick asked for the privilege of presenting his paper on "Open Ditches" at the afternoon instead of the evening session, which was granted, and Mr. Bostwick read his paper.

Mr. Morrison was invited to read a paper on "The First Railway Constructed in England," at the evening session.

## EVENING SESSION.

The Society met at 7:30 P. M., President Whitten in the chair. The Secretary, Mr. Carmichael, not being present, on motion of Mr. Goss, of Martinsville, J. F. O'Brien, of Putnam County, was elected Secretary *protempore*.

Mr. Beck not being present to read his paper, the President called for a paper written by Mr. Caisley, and Mr. R. I. Morrison, of Knightstown, read the same.

Upon the conclusion of Mr. Caisley's paper, Mr. Morrison made some very interesting remarks relative to the life of Mr. Caisley.

Mr. Morrison discussed the paper.

The next thing in order was a paper read by Mr. L. S. Alter, which was written by Hiram Burner, who was not present. The subject of the paper was "The Best Methods of Making Good Roads."

Mr. Alter remarked that Mr. Burner got his idea of street paving from the City Engineer of South Bend. The paper was also discussed by President Whitten, who said that the farmers were opposed to any change in the road laws.

The next paper was read by Mr. John W. Fawcett, of Delphi, the subject being "Bad Descriptions in Deeds."

This paper was discussed by Messrs. C. G. H. Goss, of Martinsville, J. L. Clark, of Muncie, and L. S. Alter, who gave some examples of very bad descriptions which they were called upon to correct. Mr. Clark had a case similar to one mentioned by Mr. Alter. His plan is to make his chain correspond to the Government chain.

Messrs. Goss, Meighan, Huckstep and Smith joined the discussion, which now became general, nearly all members taking part.

The business of the meeting being concluded, the President announced that adjournment was in order.

W. P. CARMICHAEL,

SECRETARY-TREASURER.

NOTE.—Further summary of the proceedings of the annual meeting never reached the printer, but the following papers were read and discussed during the sessions of January 3d and morning of the 4th. At the close of the latter session the following officers were elected for the ensuing year: President, C. G. H. Goss; Vice-President, L. S. Alter; Secretary-Treasurer, Jas. R. Brown.



## FINANCIAL STATEMENT.

## RECEIPTS.

|                       |          |
|-----------------------|----------|
| Balance on hand ..... | \$ 19.33 |
| Membership Fees ..... | 20.00    |
| Dues .....            | 93.00    |
|                       | <hr/>    |
|                       | \$132.33 |

## EXPENDITURES.

|                             |         |          |
|-----------------------------|---------|----------|
| Paid Whitten .....          | \$ 8.50 |          |
| “ Brown .....               | 2.00    |          |
| “ Carmichael .....          | 5.25    |          |
| “ “ .....                   | 6.80    |          |
| “ “ .....                   | 2.35    |          |
| “ “ .....                   | 12.60   |          |
| “ “ .....                   | 12.80   |          |
| “ “ .....                   | .75     |          |
| “ “ .....                   | 5.50    |          |
| “ “ .....                   | 10.00   |          |
| “ “ .....                   | 1.00    |          |
| “ “ .....                   | 14.75   |          |
| “ Traffic Association ..... | 2.25    |          |
| “ Whitten .....             | .75     |          |
| “ Alter .....               | 1.35    |          |
|                             | <hr/>   | \$ 86.65 |
| Balance .....               |         | \$ 45.68 |

Respectfully submitted,

W. P. CARMICHAEL,

Secretary-Treasurer.

NOTE.—The report of the Committee on Compiling and Publishing Report never reached the printer, but it showed that the thirteenth annual report, containing 176 pages, had been let to and printed by the Tribune Printing Co., of South Bend, and that the cost of same, including cuts, etc., was \$196.27, all of which had been paid out of receipts for advertisements, and in addition, said receipts had wiped out the deficit of \$145.55 carried over from the publication of the twelfth report, and enabled the Secretary-Treasurer to begin his report with a balance on hand of \$19.33, instead of a deficit of \$145.55.

## REPORT OF COMMITTEE ON ENGINEERING AND SURVEYING.

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*To the President and Members of the Society:*

GENTLEMEN:—In submitting this report in response to the call of the Society, we do not intend making any great departure from the custom of previous committees. There is certainly enough subject matter in this compound topic of Engineering and Surveying. (Which we think might well have been separated and given to two committees). We say that it is a broad field for research and investigation. "Advancement in civilization" means, to a great extent, improvement in the various departments which come under the control, or at least, the supervision of the Civil Engineer.

"Westward the course of empire takes its way." Horace Greely advised the young man to "go west and grow up with the country." But before migration can be made to a new country, or any of its resources be developed, the engineer must precede every other in planning and constructing bridges, roads, railroads, ferries, etc., thus paving the way for the vast multitude, who must and will have room corresponding to their muscle.

"Accurate work" is the watch-word of the present decade. It is the talisman of the future; the magician's wand in the hand of the civil engineer which turns everything it touches into gold. There is nothing on the calendar more plainly marked than that the man in our profession who does not fit himself for his calling, keep thoroughly posted in his business and perform accurate and efficient work, will be dropped from the ranks or go hungry while waiting for patronage. Then since it is true that millions are daily entrusting their lives to the work of our hands, let us be workmen worthy of our hire.

## RAILROADS.

New railroads are being constructed in almost every state of the union: The Bangor & Aristook, in Maine; The Pennsylvania, in Pennsylvania; Grand River, in Michigan; Florida Central, in Florida; New Orleans & Northwestern; in Louisiana, are a few of the many roads now under process of construction.

## BRIDGES.

Another bridge across the Niagara Falls to cost \$500,000; a new bridge in Boston, Mass., to cost \$1,000,000; a \$65,000 bridge a Venice, Ohio; a \$350,000 bridge at Duluth, Minn., which list might be swelled to scores, shows that the bridge business is not lagging.

## WATER WORKS.

A filter plant and other water works improvements in Boston, Mass., to cost \$700,000; Cynthiana, Ky., has voted \$40,000 for water works; a \$95,000 water works to be constructed at Danville, Ky.; Alexandria and New Haven, Ind., are to have new water works.

Not more than one per cent. of the work in this line is mentioned here, therefore it may be seen that a good supply of water is not to be made a matter of secondary importance. Besides these, we see the pulse of the nation throbbing in such arteries of business as the construction of street and elevated railroads, highways, coast and Indian surveys, tunnels, levees, artesian wells, gas wells, oil wells, irrigation sewers, street improvements, electric light plants, gas lights, electric moters, water power, dredging, breakwater wharves, channel improvements, gunboats, etc.

The subject is inexhaustable; the field is large; yet an unskilled workman, marching under the banner of the civil engineer, might be left standing on deck a long time before he is called to bat in this great and scientific game played by experts only, in all the nations of the world. And yet, while there is no room for the careless and indifferent surveyor, the careful student, the man who loves the work and

labors to make few mistakes is the one whose services are constantly needed; whose wages are on the increase yearly, and the one who will be crowded with work from all sources and looked upon as benefactor to mankind.

The Ferris wheel, at Chicago, is a rolling monument of modern engineering skill. A curiosity may be seen in a straw bridge three miles long, across Red River, in Texas, seventeen miles from Iwanah, in Hardeman County, which is rebuilt every year. A novel type of bridge has recently been completed to connect the towns of Portugalete and Las Arenas, about ten miles from Bilbao, Spain. The structure consists of a skeleton platform carried by a suspension bridge resting on iron towers. Rails are laid on both the up and down stream sides of the platform, upon which runs a frame of friction wheels, from which the car is slung by cables. The ferry car is thus only a few feet above the water, in fact, at the same level as the docks on the river banks, while the platform is of a sufficient height to permit the passage of large vessels. The car can be propelled by hand, steam or electric power. The car, which weighs forty tons, will carry 150 passengers across the 500-foot span in one minute.

The last topics touched upon by the committee whom we succeed were the Drainage Canal and the Elevated Railways of the City of Chicago. The last named are a success and had a great run during Fair. The construction of the canal is progressing rapidly. The Lafayette Dredging Company have one of the largest contracts on this work.

We will not touch upon the extensive topic of Municipal Engineering, as time and space forbid.

Respectfully submitted,

|                  |              |
|------------------|--------------|
| R. A. HOWARD,    | } Committee. |
| JAMES E. ALTER,  |              |
| CHAS. L. KINNEY, |              |



ADDRESS BY PRESIDENT WHITTEN.

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*Gentlemen of the Indiana Engineering Society.*

In looking over the published proceedings of our own and sister societies, with a view of obtaining from the several addresses delivered by their presiding officers, a few hints to be used on this occasion, I have been greatly impressed with the high grade of engineering talent, as well as the marked degree of literary merit displayed in these productions. So strong have these impressions become, that they have convinced me that any attempt on my part to prepare an address that, even with the most friendly criticism, could be considered as doing justice to the Society, would most certainly end in a humiliating failure. I shall therefore ask to be excused from attempting an impossibility, and in lieu of an annual address, be permitted to refer in a disconnected manner, to several subjects with which I have come in contact during the year, some of which may be of interest to a few of the members, and if time permits, possibly call out discussion, and discussion seldom fails to be profitable to the Society.

## PLUMBING INSPECTION.

In the City of South Bend, there has been invested nearly a million dollars in water works, sewers and drains, and service pipes and fixtures connected therewith. One-half of this investment may be said to have been incurred with a view of enhancing the sanitary condition of the city. Service pipes, drains and fixtures connecting with sewers and water mains are put in by plumbers under private contracts with property owners. The plumber is usually the only person consulted as to plans and material to be used. He also furnishes the material and labor to put it in. The quality of this material and manner in which the work is done has much to do with his profit. The work is generally

so placed as to be inaccessible to inspection after completion. House drains, while they connect with the sewers, are themselves the most prolific source of sewer gas, and therefore, defective plumbing connected with these drains, instead of benefiting the health of the inhabitants of the premises upon which they are located, may prove to be detrimental, not only to the health of the occupants of the premises, but to the neighborhood.

Scientists tell us that some of the most injurious gasses found in sewers are inodorous, and therefore their presence may not be detected until, perhaps, too late to prevent their injurious effects. That many of these drains are in a most unsanitary condition is clearly shown whenever streets are opened, for any purpose, where these drains have been laid, and it is fair to presume that much of the plumbing connected with these drains is in the same condition.

While I have no sympathy with the would-be witty scribblers for the press, with whom it seems to have become a fad to crack some chestnut of the lower Silurian age, about plumbers and their exorbitant charges, whenever there occurs a dearth of legitimate news items, for, as a rule, I believe plumbers are as reasonable in their charges as many who criticise them, and they are frequently driven, by sharp competition, to accept work at figures that makes it a temptation to use inferior material and slight the workmanship. Under these circumstances, is it the part of wisdom that the benefits expected from the expenditure of this half million dollars for sanitary purposes be jeopardized, and in some instances rendered worse than useless, for want of proper attention of the municipal government. The water board very properly exercises control over all pipes and fixtures connected with the water mains, so far as to secure the full payment of rents and the prevention of waste is concerned. If it be necessary to exercise this control where only *dollars* and *cents* are involved, is there not infinitely greater reason in matters in which health and life are at stake, that proper supervision be maintained? The condition in South Bend

is probably but a sample of the condition of many cities in the state with regard to plumbing. Should there not be some action taken to improve this state of affairs?

#### WRAY LAW ON SEWER ASSESSMENTS.

From almost the "time whereof the memory of man runneth not to the contrary," in towns and cities of the state that are incorporated under the general acts of the legislature, the cost of sewers has been assessed upon the several tracts of real estate affected, in proportion to the *benefits* received by each. It is difficult to conceive of a more equitable distribution of these costs than was thus provided for previous to 1893. The courts had ruled on nearly every point that is liable to be raised, so that the law was well understood and there seemed no reason for a change, unless it were to unsettle the whole subject of sewer assessments and make work for lawyers. But now comes Mr. Wray with his little bill, changing the basis of assessments for local sewers, and their equivalent, from that of *benefits* conferred to that of *frontage* abutting the improvement. If an assessment on the latter basis is just and right, which is sometimes the case, it is provided for in the old statutes. In many instances, however, where corner lots have been assessed for sewer privileges on their front and have connections all made, and therefore need no further sewer facilities, and afterwards, solely for the benefit of property owners on the side street, a sewer is built thereon; under the old law the cost of such a sewer would be assessed according to *benefits*, but under the Wray law the owner of the corner lot, who has little or no benefit from the latter sewer, is made to pay the same per foot front, generally amounting in the aggregate to at least double the amount that other property owners on the street, who have no other sewer facilities and for whose benefit the sewer is built, are required to pay. In other words, taxing lots 25 x 100 feet, the corner lot, for something which does not benefit it, is made to pay four times as much as the lot for whose special benefit the work is done. If that is right, then the Wray law has some

excuse for its existence, for notwithstanding the fact that under the old law such assessments *could* be made, if in the opinion of the Common Council they were just, nevertheless they would seldom be made by councils of ordinary intelligence.

For trunk sewers, while the Wray law is exceedingly verbose, it seemingly leaves the assessments practically the same as the old law. I say seemingly, for the reason that no one, not excepting the author of the bill himself, knows just what the meaning of its provisions are. It therefore appears that the only effect of the passage of this act is to change the basis of local sewer assessments from a basis of benefits conferred to one of frontage, which in some instances is clearly an outrage, leaving the whole subject in an excellent condition to produce an abundant harvest for the legal profession.

#### DRAINAGE AND DROUTHS.

Whenever the usual *dry spell* occurs in the growing season, the gentlemen philosophers, who believe that two things cannot exist at the same time without one being the cause of the other, set up the howl that the drainage of the country is causing drouths to be more frequent and severe. Without stopping to refer to statistics, which, of course, these gentlemen would not accept as proving the fallacy of their position, I would like these gentlemen to explain the cause of drouths; that there is evidence to show have occurred long before drainage was thought of in this country,—I refer to cracks in the clay found in the bottom of ditches, six to nine feet deep, in St. Joseph County. These cracks are now filled with soil from above the clay, which is of a darker color. They are an inch or more in width at the bottom of these ditches and evidently extend somewhat deeper than the ditches. They have undoubtedly been made during drouths that exceed any drouth known since the settlement of the country, and therefore, before any draining by white men could have been done. Will these wise philosophers tell us what tribe of Indians did the draining which caused these severe drouths?



## ELKINTON AS A DRAINAGE ENGINEER.

During the latter part of the last century, Joseph Elkinton became famous on account of his success in the drainage of swamps and bogs in the drift formation of England and Scotland. His methods were regarded as of so much importance that in 1795 the Parliament of Great Britain voted him £1,000 (\$5,000) as a reward for his discovery in the drainage of land. The secret of his remarkable success seems to have been in his knowledge of the geological formation in which the swamps were located, together with a careful examination of each particular case. In this way he was enabled to determine the best method of relieving the low lands from the water which, falling on higher ground, sinks through a porous soil to the water-bearing sand or gravel, to an impervious stratum, from whence it forces its way, under more or less head, through the soil, until it escapes at the surface of the lower lands, sometimes as springs and sometimes oozing from the entire surface. He seemed to rely on intercepting this water in its course before it reached the surface, or so near the surface as to be detrimental; and thus by the judicious location of a single drain, frequently was enabled to accomplish results that many drains, under different systems, fail to realize. The later discovery that thorough drainage greatly benefits retentive upland soils, even when the surface is quite rolling, the area of which lands greatly exceed that of the lower lands, to which Elkinton's system is especially adapted, lead to much discussion on the various theories proposed for the drainage of the higher lands. In the contest among the deep drainers, the shallow drainers, and the shallow deep drainers, the advocates of the stone drain, the brush drain and the tile drain, of the gridiron system, the keythroe system, or no system; of drains with the slope, drains across the slope and drains diagonal to the slope, of frequent drains and drains further apart; the adherents of James Smith, of Josiah Parks, of Josiah Trimmer, Lord Wharncliffe and others, seem to have forgotten that Elkinton ever had an existence.

Nevertheless the methods of Elkinton were founded on true principles, and where applicable accomplish results, that, in many instances, the more costly systems have failed to accomplish. These failures of the costly drainage schemes to reclaim springy, or boggy lands, have lead many to conclude that these lands cannot be drained. But Elkinton's methods were successful and economical in the drift formation of England and Scotland in 1794, and there is no good reason why they should not be equally successful in the marshes of the drift formation in Northern Indiana in 1894, and it is my belief that many of these marshes cannot be fully reclaimed without applying some of the seemingly nearly forgotten principles of the last century.

#### MOMENCE ROCK AND KANKAKEE DRAINAGE.

I am happy to announce that the removal of the celebrated "Lime Stone Ledge" in the Kankakee river, to the extent contemplated by the legislature has at last been accomplished. The width of rock excavation at the summit was three hundred feet, and the mean depth two and three-tenths feet. This work, together with the removal of the artificial dams, which, it will be remembered, was the cause of so much litigation, reduced the level of the surface of the water at the summit about four feet.

The removal of this obstruction having been generally regarded as necessary to the reclamation of the Kankakee marshes, the parties interested will now, doubtless, proceed with the work of reclaiming the marsh lands by the most popular method, namely, by straightening the river; in fact, I believe that proceedings have been instituted with a view of doing this work from Baum's bridge to the state line. The results will be watched with much interest by all, and especially by certain cranky engineers who think that a more economical and far more *effective* method might be adopted.

Just before the completion of this work, I stumbled on an explanation, satisfactory to my mind, of certain facts which previously, to me, were somewhat of a mystery. In

making the survey for the improvement, we noticed that solid rock did not appear in the bed of the river as far up stream as the location to which old river men were accustomed to point as the great rock dam that prevented the drainage of the Kankakee marshes, and just above which the water is said to have been very deep before the sand from the Beaver lake outlet was washed down and filled up the channel. As the water covered the bed, we were unable to examine closely, but from driving a rod down we determined that the removal would be nearly, or quite as expensive as solid rock, and it was so estimated as far as the improvement extended. To account for this material, which was evidently largely composed of rock, I thought of an ice gorge forming just above, scouring out the river bed and depositing the material here, but being no geologist, and our only concern being the best way to do \$140,000 worth of work with a \$40,000 appropriation, it was not necessary to verify the theory.

At Indiantown, four and one-half miles or five miles further up stream, it was asserted by some and denied by others, that another rock ledge obstructed the channel. By direction of Prof. J. L. Campbell, President of the Board of Commissioners, I examined the river at that point. Here, apparently the same material was found, but as we could drive a rod some distance into it, I reported that it was not a solid rock ledge. We were reliably informed that wells had been driven in the neighborhood sixty or eighty feet before reaching solid rock.

To account for these fragments of rock in the bed of the river at this point, sixty or more feet above the rock in place, or solid rock, and five miles up stream from the nearest outcrop, puzzled me not a little. The river at this point makes a U-shaped bend to the north and is eating into the north or right bank. It has evidently worked to the north more than the full width of the channel. The north bank is the site of an old Indian village, hence the name Indian-town. Closely set over this site are depressions which are

paved with fragments of the Niagara lime stone, (the formation at Momence), said to have been made and used by the Indians. These facts suggested to me that possibly the Indian village had formerly extended as far south as the rock appear in the bed of the stream, and that as the river washed away the bank, the stones from these old Indian habitations had settled to the bed of the stream. The probability of the Indians transporting this amount of stone from Momence seemed almost fatal to this theory, but no other explanation was suggested, and as was the case with the material at Momence, a correct solution of the problem was not a necessity to the work in hand and the matter was dropped.

The contractors began work at the lower end, and before the excavation was completed through the solid ledge, I noticed fragments of the Niagara rock in the river bed that had been worn and scratched by glacial action. When the last coffer dams were put in at the head of the improvement and the bed of the river exposed, we found the material above the solid rock to consist largely of fragments of the Niagara limestone, some of which were quite angular, while others were rounded and worn, plainly showing the scratches, or striae, peculiar to glacial action; mingled with these were boulders evidently of Canadian origin. A break in the coffer dam caused a wash into the north bank of the river, disclosing the fact that this material is not confined to the bed of the river, but extends under the surface in a northerly direction, seemingly following about the course of the slight ridge that forms the boundary of the marsh. These facts led me to conclude that this material had been deposited in its present position, not by water dammed up by an ice gorge in the river, but from the foot of the ice sheet, or glacier, which, we are told, once covered this entire region. After reaching this conclusion, a gentleman who has spent much time on the river, called the attention of Mr. Clark and myself to the fact that fragments of sulphuret of zinc were quite numerous in this drift deposit, he having



become accustomed to searching for them, could pick them out by the dozen from the other material, where I could not find a single one. In conversation with this gentleman, he informed us that the same material, (sulphuret of zinc), was quite plentiful at Indiantown. It then occurred to me, for the first time, that the formation at Indiantown was also a glacial deposit. This explanation, of the presence of the rock fragments at that place, seemed quite plausible, it being much easier to imagine that this material had been transported and piled to the height of sixty or eighty feet by the, almost, irresistible force of a glacier, than to think of the Indians conveying even a thin layer of the rock from Momence.

I have since learned from Mr. Williams, who cut several ditches in the marsh north of Indiantown, that at one point nearly a mile, and another nearly a mile and a half distant from Indiantown, he was compelled to raise the buckets on the dredge in order to avoid rocks; at the same time deep wells, in the vicinity, were sunk in the sand without finding rock. These facts lead me to suspect that the deposit at Indiantown extends northward, and was encountered in these ditches. If so, this deposit must be of no mean proportions, sixty or eighty feet in depth, and unknown width and length.

#### OLD OUTLET OF LAKE MICHIGAN.

Unfortunately for my peace of mind concerning this deposit, the last time I visited Momence I came across, in Mr. Clark's office, a copy of the Illinois Geological report, containing the report of Frank H. Bradley on the Geology of Kankakee and Iroquois Counties, in which I find the following statements:

“Whether there was or not an outlet from the south end of Lake Michigan, after the close of the drift period, there certainly was one at that point before the drift was deposited. The depth of this channel in its northern part is unknown. Its western bank is seen on the Kankakee, just above Momence, where the rock suddenly breaks off, and probes

forced to considerable depths found no solid bottom." These facts were ascertained in 1867 by Col. James Worrall, who also informs me that the same "shoulder" of rock is found upon the Calumet, nearly due north from Momence. In this part of its course, passing though very solid rocks, the channel is rather narrow, rocks having been found upon its east side and south of the Kankakee, within seven miles of Momence; the exact location of its eastern bank is as yet unknown. From this point the course of the channel is not certain, but it *probably* keeps near the State line until it nearly or quite reaches the valley of the Iroquois; then runs westerly to the valley of Spring Creek, having a depth of one hundred and sixty feet near Sheldon, and then turns south with a depth of two hundred and sixty-eight feet between Orange and Gillman, of over three hundred feet between Orange and Spring Creek Station, and of over three hundred feet between Paxton and Rantoul. As the western bank was found at Chatsworth, thus giving a width of fifteen miles or more, it is evident that the softer materials of the Devonian, lower Carboniferous, and coal measure shales and sand stones have afforded less resistance to the denuding agents than the solid silurian lime stones, which confined it to less than seven miles at Momence. At Bloomington, in McLean County, the channel is two hundred feet deep. The route west of Bloomington is unknown.

Dana refers to the above described channel in support of the theory that the glacial period was one of high-latitude elevation, as follows: "Further, there is evidence, as shown by F. H. Bradley, that waters from Lake Michigan, in some era, cut a channel from the south end of the lake southwestward to the Mississippi, following a course south to the north line of Iroquois County, Illinois, and thence southwest through Champaign and McLean Counties."

Now of the entire length of this channel, from Lake Michigan to the Mississippi, the only portion that seems to be well defined lies between Bloomington and Iroquois, near the east line of Illinois, being approximately one-fourth of

the entire length. For the one-fourth of its length which connects with the lake, all the evidence shown is the "shoulders" of rock upon the Calument and Kankakee for the western bank, and the rock said to have been found within seven miles of Momence for its eastern bank. The latter being the Indiantown rock, which is, in fact, less than six miles from Momence, in a straight line, and only about four miles in a straight line from the outcrop of the rock on the river above Momence. Instead of being "very solid rock," it is fragmentary, and certainly would not withstand a current of water or ice that would erode the solid Niagara lime stone. It is true that this drift, as I believe it to be, may have been deposited in the old Lake Michigan outlet, but that would leave us no trace of an eastern bank between the lake and the Iroquois. As to the western bank of this supposed channel, the excavation at Momence shows that, in the distance, from the solid outcrop to the deep water above the drift, an angle of dip of the strata of from six to twelve degrees, would fully account for the difference in the surface of the rock. The Wabash Arch, described by Prof. Gorby, runs nearly parallel with this supposed ancient channel from Momence north, and in view of the fact that Prof. Gorby informs us that in other places along this upheaval, the strata dip from one to two to eighty or ninety degrees, it would not seem improbable that these "shoulders of rock" were formed in that manner. If they were, and the Indian-town formation is drift, then of all the evidence given to prove the existence of the Lake Michigan outlet, there remains none whatever between the Lake and the Iroquois river. Furthermore, the Wabash Arch, between Momence and the Iroquois, would probably have to be cut through if this channel were a reality.

The lower half of the channel, from Bloomington to the Mississippi is said to be unknown. We therefore have for this Lake Michigan outlet, a channel, the lower half of which is not known to exist, one half of the remainder appears to be quite well defined, but from its general trend, Lake

Michigan would not necessarily seem to be its source, and the proof of its being connected therewith, to say the least, is not very clear. In leaving this subject, I desire to say that I have only endeavored to indicate the light in which the proof of the existence of this Lake Michigan outlet appears, not to the trained mind of the geologist, but to the ordinary mind of one who don't know the difference between a trilobite and a potato bug.

#### NIGGERHEADS FOR ROAD METAL.

There are localities which are well supplied with boulders or field stone (niggerheads), in which the highways are almost impassable for many months in the year, but so much having been said about gravel roads, the impression prevails that, in the absence of gravel, good roads are practically out of the question.

It has been found however that sand on clay soils can be used with fair results, but the use of field stone, or boulders, that, in many places, so encumber the ground that farmers pile them in every out of the way place, to get rid of them, are seldom thought of in connection with road improvement, unless it be to condemn the practice of hauling heavy loads of these boulders, on narrow tired wagons, over the roads. I have driven along roads in mud hub deep, while on each side were fences made of stone in order to clear the fields for cultivation, and yet the farmers would tell you, there was no material to be had with which to improve the road. I have known of instances where sand has been hauled seven or eight miles, to be placed on clay roads, along which were piles of stone which, if crushed, would have made a most excellent road, at one half the cost of the sand road, which at best would last but a few years. These boulders are largely granite and quartzite, and when crushed are much better than the crushed limestone so largely used for macadamizing roads.

It has been estimated, by good authority, that it is cheaper to pay freight 200 miles on granite for road purposes than to use limestone found in the locality. The crushing of these



boulders thus producing the very best road metal would not be expensive, and on a well drained grade, one-third to one-half the thickness of metal could be dispensed with, if this better material were used. The machinery for crushing is not expensive. It can be run with the ordinary thrashing engine. The entire outfit can be moved from place to place, with as little trouble as is required for moving a thrashing outfit. The crushers are not expensive and every township might have one or more of these machines in localities that need them. Why then should we not use niggerheads for macadamizing country roads.

A PAID SECRETARY.

Now a few words in relation to our society. The experience of the year has convinced me that we must have a paid secretary. The work requires more time than we can expect any member to devote to it without some compensation. The greater portion of the work can be done by one person better than by two or three. In the matter of securing advertisements all the members should assist. I do not think we have a single member who could not by putting forth a little effort secure from one to five pages. The secretary could do much in this line also, and all of the other work. Then by getting out our reports on time so as to give our advertisers the worth of their money, I am satisfied that we could pay our secretary, in part, at least, for his services.

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## THE LOCATION, DESIGNING AND CONSTRUCTION OF OPEN DITCHES.

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BY L. A. BOSTWICK.

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*Mr. President and Members of the Indiana Engineering Society:*

By request I have undertaken to write a short paper upon "Open Ditches," an apparently easy question to write upon, but one finds after he has tried to locate, construct and maintain one there are many difficult questions for him to answer.

Ditches are extensively used for irrigation and drainage, it is of the later I wish to speak more particularly.

Ditches for irrigation were built in Egypt in the Bible times, also in Italy in the 12th century.

The largest ditch for irrigation is one in India called the "Ganges Canal," which is 10 feet deep, 170 feet wide and 900 miles long.

Ditches for drainage were probably first used in Holland where drainage districts were formed which date back beyond the earliest history, one in particular the Rijnland was recognized by the King in the year 1253.

Ditches for drainage may be divided into two classes: First—Those in which the flow of water is not sufficient to prevent the growth of vegetation, called surface ditches. Second—Those which have sufficient flow of water to prevent the growth of all vegetation, called main ditches.

Surface Ditches.—As the flow of water in this class of ditches is in the spring and autumn the manner of construction should be far different than in the Main Ditches (or in the second class) for the reason that after the spring freshet there is no water in the ditch, and grass, weeds and willows grow in profusion and collect all manner of drift and silt and in a short time fill and ruin the ditch.

This class of ditches should in my opinion be constructed very wide on top and narrow in the bottom and in some cases an 8 or 10 inch tile laid 2 or 2½ feet deep in the bottom will greatly improve them, they should be sodded over so that the grass may grow instead of weeds and willows.

These ditches will be easily cared for as the hay will be worth its cutting and in case this runs through pasture land and will not be damaged by cattle.

This class of ditches needs no bridging because they can be crossed at any place.

Main Ditches.—It is this class of ditches which furnish the outlet for surface and tile ditches, and in many cases become living streams, and in the spring and autumn are crowded to their utmost capacity, while in summer there is

scarcely any water in them, it is this feature which makes the location, construction and maintenance more difficult, because at times freshets wash away the banks and leave sand-bars and other obstructions which have to be removed.

To reduce the wearing away of the banks to a minimum great care should be used in locating the ditch to keep it as free from bends and curves as possible, often cutting through high land rather than making bends and curves in the ditch.

It is not necessary to follow all the windings of the low land, since a main ditch is not intended for direct drainage but to carry off the water after it has been gathered together by the surface and tile ditches.

One of the things to be avoided in the location of a ditch is sand in the form of quick-sand or running sand and when it becomes necessary to cut through sand pockets or hills, I have seen bog iron ore used as riprap to very good advantage, (bog iron abounds in many of the marshes of Indiana.)

Never make any crooks or bends which can be avoided, for every bend tends to increase in curvature by the scouring away of the material from the outer bank and the depositing of silt along the inner bank, often increasing until a loop is formed with only a narrow strip of land between the two encroaching banks, finally a cut-off occurs and a waterway is formed through the strip of land and the loop left separated from the ditch forming a horse-shoe shaped lagoon.

It has been the practice in irrigation ditches to construct them with a slope of  $1\frac{1}{2}$ -1, 2-1 or 1-1, with ditches for drainage purposes it is common to give them a slope of  $1\frac{1}{2}$ -1 or 1-1.

In the ditches which I have located I have used a slope of 1-1 as it conforms nearer to a natural channel; where the banks of the ditch are not sufficiently stable to maintain the slope they may be protected with gravel, bog iron ore, or stone, used as riprap.

The natural slope of the earth is from 3-1 to 1-1, but we have trouble in maintaining a slope, for the natural form of a channel is one with nearly perpendicular banks.

Main ditches should have, first: sufficient depth to give outlet to all surface and tile ditches and sufficient width to carry ordinary high water, the channel should then conform as nearly as possible to a channel the depth of which is one-half its mean width, since this form of channel is most economical and gives the greatest velocity to the water.

To lay a grade which will fit the ground closely and give a uniform velocity to the water is often hard to do as the natural slope of the water-shed is often found very uneven; any break in grade which decreases the velocity of the water should be avoided if possible since it will cause sand-bars to form which often fill the ditch.

Each ditch has features peculiar to itself and no prescribed rules can be followed.

The following table may assist in surmounting some of the difficulties by showing approximately the velocities which are required to move different materials:

0.25 feet per second moves fine clay.

0.5 feet per second moves loam and earth.

1.0 feet per second moves sand.

2.0 feet per second moves pebbles 1 inch in size.

4.9 feet per second moves spalls and stones.

6.0 feet per second moves large stones.

The mean velocity in a channel may be somewhat larger than these values before the materials will move, because the velocities along the bottom are less than the mean velocity.

Capacity of open ditches:

The quantity of water flowing in an open ditch depends upon the inclination of the bed of the stream, the depth of water, the area of the cross-section of the stream, the portion of the cross-section of the bed and banks that is in actual contact with the water (called the wet perimeter,) the smoothness of the surface in contact with the water, and the effect of the wind upon the upper surface.



Of the various formulas presented for this purpose, Kutter's is the simplest and most accurate. It is

$$Q = m a \sqrt{r f}$$

in which  $Q$  is the discharge in cubic feet per second;  $m$  is a correction co-efficient,  $a$  is the area of the cross-section of the stream,  $r$  is equal to the area of the cross-section, divided by the length of that portion of the cross-section of the bed and banks that is in actual contact with the water, and  $f$  is the fall per foot. All the dimensions must be taken in feet.

The reliability of the formula depends upon the value assigned to the co-efficient  $m$  to correct for friction. Experience shows that it is more for large or deep than for small or shallow streams; more for high than for low velocity; and more for smooth than rough channels. By selecting results of experiments, conditions somewhat like the ordinary drainage ditch, we can get a mean value which we may use with some degree of confidence. For value of  $r$  (defined above) equal to  $\frac{1}{2}$   $m$  is 40; if  $r$  is 1,  $m$  is 45; if  $r$  is 2,  $m$  is 55; if  $r$  is 3, then  $m$  is 65; if  $r$  is 4, then  $m$  is 70; if  $r$  is 5, then  $m$  is 75; if  $r$  is 6, then  $m$  is 80.

The preceding results are for a clean ditch through earth free from stones; if the ditch becomes obstructed with grass, of course the co-efficient should be very much reduced.

To change the above formula so that it will express the number of acres, represented by  $A$ , from which a given ditch will remove 1 inch of water in twenty-four hours, we multiply by the number of seconds in a day and divide by the number of cubic feet in an inch of water over an acre; then

$$A = 48 m a \sqrt{r f}$$

If it is desired to remove only two-thirds of an inch of water in twenty-four hours the formula becomes

$$A = 72 m a \sqrt{r f}$$

On the basis of removing a trifle less than half an inch per day the formula becomes

$$A = 100 m a \sqrt{r f}$$

To illustrate the use of this formula let us assume that it is desired to find the number of acres from which a ditch 5 feet on the bottom with side slopes at 45 degrees will remove 1 inch of water in twenty-four hours, the fall being 2 feet per mile and the water 3 feet deep in the ditch. The wetted perimeter is  $5 \times \sqrt{8} \times \sqrt{1} = 15.6$  feet. The area is  $3 \times 8 = 24$ ,  $r = 24 \div 15.6 = 1.8$ . Since  $r$  the mean hydraulic depth, is 1.8, the co-efficient  $m$  is about 52. A fall of 2 feet per mile is equal to a fall of .000379 feet per foot, which is the value of  $f$ . Substituting these values in the formula and working the arithmetic we find that this ditch will in twenty-four hours carry away a half an inch of water over 3,240 acres.

It is believed that the two preceding sets of formula if carefully used, are sufficient for the intelligent planning of large systems of drainage. Other questions than those here discussed will arise, but probably the above are the only ones which involve an appeal to experiments and mathematical formula.

How shall we construct these ditches?

It has been the custom in this part of the state to build large dipper or bucket dredges which cut their way from the source to the outlet, floating in the ditch which they cut, making a larger ditch at the upper end than the specifications call for; this method of constructing is a bad practice, because the upper end of the ditch is larger in proportion to the water carried than the lower section which as a consequence diminishes the flow of water at the upper section or increases the flow of water at the lower section, or both, and no matter how accurately an engineer may proportion the ditch this practice ruins it all and it has to adjust itself aided by the yearly cleaning, it often times takes many years to become what it should be at the start, on the other hand if the ditch had been constructed from the outlet up without the aid of dams the soil would be allowed to settle, solidify and become more permanent before it came in contact with running water and sides sloping according to specifications

and the earth deposited at the proper distance from the ditch it would save a large amount of cleaning which is necessary in some ditches.

The custom of using floating dredges necessitates the commencing at the source and working to the outlet, especially in small ditches the dredge has to cut a ditch large enough to float the dredge and is twice or three times as large as the specifications call for, thus spoiling the ditch.

You might ask what method should be used in excavating open ditches, if floating dredges are not proper and in answer I would say, floating dredges may be used in enlarging old ditches where there is sufficient water to float them without making dams, but where new work, especially small ditches where the bottom width is from 6 to 30 feet, I believe that clam-shell dredges are best adapted to this kind of work:

First—Because the ditch can be excavated from the outlet up stream completing each section as you go and in this way always having an outlet for the work which has been completed.

Second.—The ditch can be excavated so as to conform to the specifications.

Third.—Because the excavated earth can be thrown further from the bank of the ditch and be left in better shape.

Fourth.—Because it can be done cheaper as there is no extra excavation.

The use of this kind of a dredge for digging ditches for drainage purposes is no experiment as a dredge of this kind was used in digging a ditch across the Newark meadows in New Jersey; in Chatham County, Georgia; and I have also seen similar dredges at work in western New York; three dredges are generally mounted upon a platform or car and work backward on the ground ahead of the ditch.

## BAD DESCRIPTIONS IN DEEDS.

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BY JOHN W. FAWCETT.

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Of late years I have not been officially engaged in surveying, but have given my attention generally to private surveys, conveyancing, examining titles, etc., and in this way have made some observations which I will briefly mention, hoping that it may be of some interest to Surveyors, and others as well.

It is the astonishingly loose and careless manner in which descriptions of land are so often written in deeds, of which I wish to speak.

The title to a man's home is no trivial matter, and therefore the care and precision with which a conveyance should be drawn is manifest, and the importance of such care in describing land becomes more prominent, upon the inspection of the Court records, showing, as they do, the vast amount of money wasted, the worry and trouble involved in litigation and in suits to "quiet title," and the cause of which, nine times out of ten, is traced to the abortive attempt of some person to do something he knew nothing about.

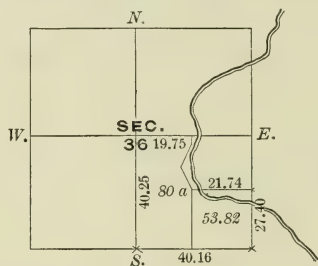
I have frequently found where the scrivener had confounded the courses and distances for bearing trees with the courses and distances of boundaries, and it also frequently appears where the measurements are made in chains and hundredths, that the hundredths have been mistaken for full chains, and thus they make a "confounded" mess of it.

Take, for illustration, the following, from the record of a suit to quiet title, brought at the last session of the Circuit Court of Carroll County:

The intention was to convey 53.82 acres out of a tract of land which had been surveyed, and the boundaries were as plainly given as it is possible to write, and are shown by the plat herein, and which read as follows: A part of the southeast quarter of section No. 36 in township 26 north, of range



2 west, beginning at the southeast corner of said section, thence W. 40.16 chains to a stone; thence N. 40.25 chains to a stone; thence E. 19.75 chains to a stone; thence S.  $5^{\circ}$  W. 3.36 chains to a sugar tree 20 inches in diameter; thence S.  $30\frac{1}{2}^{\circ}$  W. 3.63 chains; thence S.  $11\frac{1}{4}^{\circ}$  E. 6.15 chains to a stone; thence N.  $89\frac{1}{2}^{\circ}$  E. 21.74 chains to a stake; thence South 27.40 chains to the beginning, containing 133.82 acres.



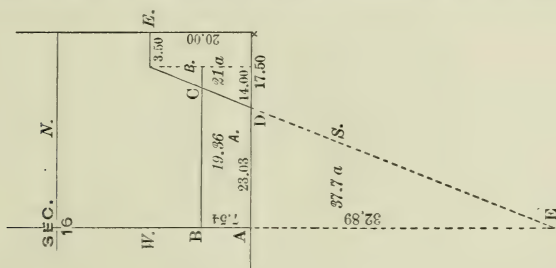
The deed was written by a Justice of the Peace, and this is how he wrote it: A part of the S. E. qr. of Sec. 36 T. 26 N.; R. 2 W.; beginning at the S. E. cor. of said Sec.; thence W. 40 p. & 16 chains to a stone; thence N. 40 p. & 25 chains to a stone; thence E. 19 p. & 75 chains to a stone; thence S.  $5^{\circ}$  W. 3 p. & 36 chains to a sugar tree 20 inches in diameter; thence S.  $30\frac{1}{2}^{\circ}$  W. 3 p. & 63 chains to a stone; thence S.  $11\frac{1}{4}^{\circ}$  E. 6 p. & 15 chains to a stone; thence S.  $89\frac{1}{2}^{\circ}$  W. 21 p. & 74 chains to a stake; thence S. 27 p. 40 chains to the beginning, containing 133.82 acres, all the above real estate, except 80 acres heretofore sold to Wool, out of the west side of the above described real estate, containing 53.82 acres.

This man certainly had no idea of measurement, and perhaps the only conception he had of a pole was a small tree with the twigs trimmed off, such as we see sometimes on fences in the woods, or he might have been thinking of a hoop-pole or something of that kind. The area embraced within the boundaries as he had it, if made to close, would be over 600 acres; but as he never gets clear around the tract of land he was trying to describe, and never gets back to the beginning, it amounts to nothing, and it cost the owner over a hundred dollars to get a deed for his land.

I was called on not long since to locate a division line, where the owners were about to put on war paint, one of the parties, Mr. A., an attorney, by the way, contending that *settled rights* should not be disturbed by surveying.

From the description in this deed it appeared that about twenty-five years ago his land had been set off by an order of the Court, in a suit of partition, and the description was as follows: A part of the S. E. qr. Sec. 16 T. 25 N., R. 2 W. Bounded as follows, beginning at the S. W. cor. of said qr.: thence E. along the south line of said qr. to B's line, far *enough to include 19.36 acres*; thence W. in a line parallel with the S. line of said qr. to the W. line of said qr.; thence S. with said W. line to the beginning.

There being neither bearing nor distance given, it became necessary to search for data upon which the problem could be solved. Luckily the boundaries of B's land were pretty well defined in the record, and I was able to obtain the different angles, and after finding the length of the line *A D*, by measurement, the solution was easily made as follows:



$$\frac{20}{14} = 1.42815 \text{ Tan. } D. 55^\circ.$$

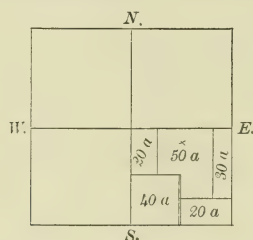
Then produce the lines B. A. and C. D. to meet in E. forming the triangle A. E. D. Then  $\text{Tan. } 1.42815 \times 23.03 = 32.89 + \text{ch.} = \text{A. E.}$  and  $32.89 \times 23.03 = 75.74567$ ; and  $\frac{75.74567}{2} + = 37.8728$  area A. E. D. and,  $37.8728 + 19.36 = 57.2328$  area B. E. C. Then  $\sqrt{37.87 : 32.89} :: \sqrt{57.23} : 40.43 + = \text{B. E.}$  and  $\text{B. E.} - \text{A. E.} = 7.54 + = \text{A. B.}$  the distance required to cut off 19.36 acres.

And on measuring the line *A B* it was discovered, to the amazement of Mr. A., that the fence supposed to be on the

line *BC* and which was built over twenty years ago, was too far south and on his land by about fifteen links; and so "settled rights" were not disturbed, and the fence stands there still.

The point here is to show that it was hardly possible for the commissioners to have properly set off a tract of land like the above without the aid of a surveyor, and further, that if the services of a surveyor had been called, in all probability the fence in question would have been in the right place.

I often find, in the examination of titles, lands described as follows: All that part of the southeast quarter of section 15 T. 25 N., R. 3 W., except twenty acres in the S. E. corner of said qr.; also except thirty acres on the east side of said qr.; also except twenty acres in the northwest part of said qr.; also except the southwest qr. of the southeast qr. of said section 15, in township and range aforesaid, leaving the amount hereby conveyed 50 acres more or less. The intention of which would be indicated by the following plat; but the absurdity of such a description needs no comment.



But there is no law to prevent any person from writing deeds, nor am I willing to say that there should be, but there ought to be some liability on the part of the man who assumes to do such work. No man has a right to be ignorant of the work he undertakes to do, and if he does it through ignorance, in a manner to the hurt and damage of his employer, he should be accountable for the damage. Every description should be written with such certainty that it would stand on its own merits and not require a Court to determine its meaning or intention.

I think the laws relating to transfers of land and the records of the deeds could be so amended as not to work a hardship on any one, and yet be a great improvement on the present system.

The Auditor should be required by law to keep correct and *accurate plats* of all the lands in his county, not mere pencil sketches, as are now generally found in the auditors' offices, and it should be made his duty to closely and critically examine every deed presented to him before he enters it for taxation, and if the description in the deed does not agree with the plat in his office, he should refuse to transfer it until it is made to agree. And should the description be any other than one of government divisions, or aliquot parts of a section, or should it not be a rectangle or susceptible of plain boundaries, it should then be referred to the Surveyor, who should proceed at once to make a survey and should make a correct plat, and a new deed should be written and together with the Surveyor's plat should be presented to the Auditor, who shall enter the plat on his plat book, and should then make the transfer, and the deed could then be recorded.

This might cause some inconvenience by the delay, but the inconvenience caused in this way would be far less than that caused by a law suit for possession, or a suit to quiet title to lands already bought and paid for.

I am aware that objection to all this would be made, and it will be said that in order to carry out such strict laws that Auditors and all persons who write deeds would necessarily have to understand surveying. Well, a little education in the matter would not be hard to attain and would be harmless to those acquiring it. But it would drive all such work to the surveyors, let it go there, for, from the very nature of it, that is where it belongs.



## DESCRIPTIONS IN DEEDS.

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L. S. ALTER.

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From the earliest history of the world to the present time the transfer of ownership of land has been one of the most sacred, lasting and binding obligations of all financial dealings. It seems from history that Adam and Eve did not own the land they occupied, but were tenants only, with a conditional life lease, which conditions they failed to comply with and were forcibly ejected, and the sheriff stood guard to prevent them returning. But people being few in number and land plenty, they had but little trouble for awhile; but Cain and Abel got into a "racket," and I believe if there had been a good partition fence between them, so Abel's stock could not have got into Cain's grain, this first case of bloodshedding would have been prevented. From that time down to the present, there has been trouble among mankind over their division lines.

Am I much out of the way when I say that three-fourths of all our wars, both personal and national, have been over questions of boundary, either in location or trespassing over the same.

Hence the importance of a well-defined boundary, which should be well marked and easily relocated if not already well defined on the ground. The first and most important requisite is an accurate and easily understood description. The second is the finding and marking of the same on the ground. The former is determined by the written transfer; the latter by the surveyor. If the first is definite and accurate, *i. e.*, correctly drawn, the chances for error in the latter case are small; but if there is an error in the first, the chance for correctness in the latter case is small.

Now, as real estate is the most permanent and durable of all property, the points referred to in a deed should be of the same character or as nearly so as possible. Bear in mind that fences, trees, roads and buildings are all temporary and

liable to be moved or destroyed so completely that their former location is forever lost. But section lines and corners, together with their subdivisions, are fixed, legally at least, for all time, and for real estate purposes they are the only fixed objects we have. All temporary objects may go, but section lines and corners remain forever, so far as our purposes are concerned. Feet, rods, chains and links may vary, and do vary, but section lines do not.

Now, with this idea in view, the remedy for inaccurate descriptions is simple and plain; make all descriptions in reference to the section or some definite subdivision of the section, bearing in mind always that the legal and theoretical section contains 640 acres, but the section you are making your description in does not contain just that amount; it may have, if an interior section, 600 or 680 acres; if exterior, it may vary from 150 to 800 acres.

To illustrate the error so common among real estate men and deed makers: Mr. M. sells Mr. D. 50 acres of land off the west side of the northeast quarter of section 28, described as follows: Commencing at the northwest corner of said quarter section, thence east 50 rods, thence south 160 rods, thence west 50 rods, thence north 160 rods, to the place of beginning. Now, this being an interior section, I will venture to say there is not a real estate deed maker in the county (and we have scores of them) but that would say that this was an iron-clad description, perfectly good, and many surveyors would pass on it. But the facts are, it lies next the Michigan Road lands and the section is  $6\frac{26}{100}$  acres short on the north side, hence Mr. M. has sold one acre more land on the south than he owned. Mr. D., finding by the records that he is short north and south, has the land surveyed, and lo! the section has a surplus of six acres instead of a shortage; hence Mr. M. has two rods of land left on the south side of D.

Now for the second cause of trouble: All because the maker of the deed was trying to be doubly sure of his description.

Now, never give a dimension that can be described by a subdivision. Dimensions vary; subdivisions do not. Again, N. sells S. 30 acres off the north end of the east half of the northeast quarter of section 32. Does he mean the north three-eighths of this tract, or does he intend to sell just thirty acres extending from the section line to the one-eighth line and sufficiently far south to contain just thirty acres? In this case the tract was about five rods short east and west.

State distinctly what is meant, giving the section or subdivision of section. If your clients insist on having the dimensions given, then state distinctly whether it is government or legal measure you mean, or whether actual or standard measure is intended. Surveyors will readily understand the difference between these two methods of measurements.

#### DISCUSSION

was indulged in by Whitten, Graves, Morrison, Fatout, and others. The general conclusion was to make all measurements correspond to the original; that 50 rods should be <sup>50</sup>/<sub>160</sub> of the distance between section corner and quarter corner, where the line is recorded full, and not what our standard tape lines make it.

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## HOW TO UTILIZE THE WATERS OF THE KANKAKEE.

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BY JOHN L. CAMPBELL, LL. D., CRAWFORDSVILLE.

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I want to say a word in reference to the Kankakee. It was my duty, as a member of the committee which was organized for the purpose of removing the rock obstruction at Momence, to have the good fortune to employ Mr. Whitten as engineer in charge, and I am very glad my successors in office are as wise as we were, to continue him until the work was completed.

The original survey of that part was very carefully done by Mr. Whitten, assisted by Mr. Clark. It has been repeated to you so often, it is not necessary for me to repeat. The experiments were made by them with great care at cross-sections of every fifty feet, and where necessary every twenty-five feet, and the work was so completely examined there was no disappointment in it. I need not enter into the office of the Commission of which I was a member. There was a question that came up with the Eastern Illinois railroad, so I refused to go forward with the completion of the excavation until these difficulties were removed. The law required we should have a clear right of way, and we failed to obtain that from the Eastern Illinois railroad, and finally a new Commission was appointed, one old member only remaining and the two other gentlemen being new members, Mr. Dunn and myself having resigned. I think this work is a matter of great importance to the State; not that it will drain to any large extent in Indiana. I never have claimed, nor have other engineers, that this would be the immediate result of the removal of the rock at Momence. It would not do it, because the river at the state line was above the obstruction and consequently it would only furnish a channel for proper improvement. I used in my report in 1882 this language:

“The removal of the obstruction at Momence is essential to the proper improvement of the Kankakee river.” I think the thing has been done which ought to have been done, and if the Kankakee receives that attention in the future, which we know it will, every one will say that the first and proper thing was to remove this obstruction.

Since my report of 1882, the main portion of which I still adhere to, although some of my friends differ from me materially in regard to some of the suggestions which I then made, yet I still believe that the suggestions made in my report in 1882, for the improvement of the Kankakee, are right, and when the improvement is made it will be made in this line, and in further proof of this I am glad to mention the improvement that has been made on Little river from



Fort Wayne to Huntington, which has been done on this same general plan, and the people are well satisfied with these improvements. Those of you who are acquainted with that marshy land will remember what it was before, and now they will see a very great change. While the wooded portion of it is yet unreclaimed, it is only a question of a few years, when you will see farms through the whole line of the marsh that will repay many, many times over the cost of the improvements, and this is in accordance with the recommendations I made in my report in 1882. I have only two suggestions to make, and I had better make these instead of reading my notes in reference to the future use of the Kankakee river.

I am sorry that I have not a blackboard here to draw an outline of the marsh along the Kankakee, because I find that people will not listen to figures. Ninety-nine one-hundredths of the people of Indiana still regard the Kankakee as a low marsh that could only be recovered like the low lands of Holland, by pumping. If I could only get the engineers of this State to take the matter in hand, to prove to the people that we have a vast swamp that has a mean elevation of over seventy-five feet above Lake Michigan. It is entirely possible, at a considerable expense, for the Kankakee region to be recovered, so that instead of a so-called low, sickly marsh, it will be as dry an elevation and as elegant as any part of the country, and much of it very fine land. There is, of course, a great deal of poor land in the marshes.

The only two points I want to speak of are these: The Kankakee river, as you know, runs 240 miles in length, and the improvement, according to my survey, was eighty miles, which was too *short*. The only change that I would make instead of that eighty miles, I would make it *twice that length*. It has now a fall of four inches per mile, and reducing the distance to eighty miles would increase it to twelve inches a mile, which would give a flow in there which would entirely destroy the flow of water, and would dam it up and prevent the flow. At one time I felt like abandoning

the Kankakee. The dynamic equilibrium and the crookedness of the river is due to the places over which it flows, but since it flows through a loose, sandy soil, *it must* be crooked. The stream of water flowing down the channel takes up the soil and carries it forward and it soon becomes saturated with substances held in solution, and there must be a deposit there and this deposit must be in the line of flow, and this flow in this case would be in a straight line. Now, as this is carried forward in its place it is retarded. The substance held in solution is dropped in the flow and the river begins its side-way course—the stream is going crooked in proportion to the looseness of the soil over which it flows, and hence the Kankakee is crooked because it flows over a loose, sandy soil, which is dammed up, and it must be reduced to that dynamic equilibrium.

Now, the improvement of the Kankakee will bring in difficulties of that kind which are almost unsolvable. It is not how to get rid of the water, but how to take care of what there is. The water will flow, but the trouble is, it carries other things with it. The difficulty can be reached by the improvement of the channel, and in that Mr. Whitten differs with me, but I believe I am right and he is wrong. It is a narrow difference, you understand.

The Kankakee will divide itself into two parts, and the gentlemen in the western part will have to take care of it from the North Bend, which is Baum's bridge. The river then goes northwest, then off to southwest. The gentlemen there must take care of it. If they only improve the marsh there they will have enough to do. But the suggestion I have to make for the upper part is to relieve the Kankakee of a portion of its water at Baum's bridge. The elevation of this point is seventy-five feet above Lake Michigan, which is only twenty-five miles distant. That point I wish to emphasize particularly, seventy-five feet elevation to Lake Michigan. Those of us who have lived upon the Kankakee and tasted its waters and enjoyed its fish, know it is a healthy place. The Kankakee water is as good as any man ever drank

in the world. I am not speaking of this from a chemical analysis, because I never made one. I have the endorsement of every man who ever lived on the Kankakee. I heard Gen. Lew Wallace say it was the best place to go to in the world. I propose that the Kankakee be relieved of a portion of its water at Baum's bridge by laying a channel through its bank on the north side, and running through this you will soon strike that low land along Lake Michigan extending out fifteen miles or more. The Kankakee is seventy-five feet higher than the Lake. Now, you can quite readily see that if any person wants water, and plenty of it, for a new city at the mouth of the Calumet, where I think ought to be a great city of our own State, and which would finally rival other cities, or if you want to use it for other cities, there is abundance of fall by which you can carry this water from this point to a distance, so far as that place is concerned, along over fifteen miles. I don't mean to say you would strike the Lake at fifteen miles, but the lake plain. That is the obstruction that stands in the way. If a chemical analysis will show that it possesses proper elements for good water, there certainly is a source of value in this Kankakee in the future development of our State or in the use of the water in other cities. In using the water of Lake Michigan for Chicago, where they take the water out of the lake, other water must fill the hole where they take the water out of, and water will run in and carry the offal of the city, diluted, of course, the further out they go. You know in Chicago to-day they say boil the water when the wind blows from the west. Whenever the wind blows from a certain direction they say the water is not good. It never will be good. There is no other place in the vicinity of Chicago where they can get good water, except in the Kankakee. If it is the kind of water I believe it to be, and what it seems to be, I believe that that problem would assist us in one particular.

Now I have one other problem which is perhaps more visionary than this. Solving the problem which has been

agitated for years. That is, connecting the waters of Lake Michigan with the Wabash for a ship canal. This has been the desire on the part of a great many people, and there was a survey by the government of this, but there has never been a survey of the part I want to submit to you. Two surveys have been made, one from Michigan City striking Tippecanoe County, and one through the northern part of the State and past Cedar Lake. It is very difficult to construct a canal. The right line in my judgment has never been attempted, and that is the point I want to bring before you. I believe there is a perfect route for this work which can be carried along. That is this: Take the same point I mentioned before, using the Kankakee as a summit level and feeding it both ways; you can at once see the result; using about fifteen miles of the river until you come to the upper end of the lake. Now this I believe to be an entirely feasible scheme, and I think it would warrant a careful survey on the part of the government, because there is no problem in connection with the development of this country as important as the connection of the waters of Lake Michigan with the Mississippi system. Now if we can secure that connection through the Wabash, the advantage to Indiana is apparent. There is no stream that will furnish the summit anywhere around the lakes from Buffalo to Dubuque. There is no place you could go along there and find at the summit a stream of water that is equal to the supply of water for the purpose.

Now if you can simply imagine a canal with the Kankakee as summit level and then feeding both direction, one down to Tippecanoe and one down to Lake Michigan, you have the scheme I propose for your consideration, and upon which I think we ought to take some action for some improvements. Other countries spend \$80,000,000 to run a canal into the interior, and here is a proposition of not much over forty miles, to connect the waters of the Wabash with the waters of Lake Michigan. I do not propose to drain Lake Michigan into the Wabash, as they do in



Chicago; they propose to take water out of Lake Michigan. Understand, I propose to use the Kankakee as a summit level both ways. Now the question was asked me this morning, "Have you abundance of supply for a canal there?" There are sixteen hundred square miles of territory which belong properly to the drainage basin of the Kankakee. Abundance, I was going to say, for two or three canals. I may stop here. I don't know as I have anything further to say on the subject

#### DISCUSSION OF THE SUBJECT.

Morrison.—I move the address of Prof. Campbell be referred to Printing Committee to be entered into our report, and the thanks of the society be give to Prof. Campbell for the address he has favored us with. Carried.

Clark.—I have but little to say about the water supply, but I was requested by the Commissioners to take a measurement of the flow this summer. It was probably the least flow the Kankakee ever had. The oldest settlers said so, and after very careful measurement the flow was 407 feet a second. Now the minimum flow has been 1,071 in 1871. It was this Father Stephan who was the other engineer for the Kankakee drainage who secured the average flow in 1871, but I never saw the water so low as this year. It seems as though the supplies were all cut off.

Campbell.—The Kankakee River is not as large as it was then.

Whitten.—Did you ever make an estimate of the cost of that canal.

Campbell.—No, I did not because I had no means of determining whether there might not be stone there. My own judgment is that there is not, but there may be; besides that, the question of cost, so far as that is concerned, ought not to have entered the case. We know it would not cost anything like the scheme to take the water from the level of Lake Michigan to the Mississippi. It does not matter whether it goes through Indiana or Illinois. The distance cannot be very great. I explained the Chicago scheme is to

take water from Lake Michigan. Now the question or difference is answered by a single remark and I can give you the exact figures. The elevation of Lake Michigan is 585 feet above the sea level. Now there is the summit. Now the summit level of your canal, according to your Illinois system, is 585 feet. The summit level at Baum's bridge is 606 feet. There is the difficulty of getting between Lake Michigan and the Mississippi. A large proportion of this is soil in Indiana and a great deal of stone also. Those are general facts I cannot answer in detail.

President.—I would like to ask Prof. Campbell if he has any doubt about the supply from Lake Michigan being sufficient.

Campbell.—I sent to the engineer of Chicago a few days ago, asking for surveys and elevations, and he said they were not in such a shape that they could reply, but as soon as they were in readiness he would give me them; but if I understand the Chicago system, it is going to be an enormous drainage upon Lake Michigan. I confess I don't know the details enough to talk about it as I would like. They propose to take a river out of Lake Michigan at Chicago sufficiently large to drain Chicago river the other way, and consequently the drainage of Chicago is down into Illinois river, and about its flow there Mr. Whitten speaks. In the plan I proposed I do not propose to use water for draining purposes. I want to use the canal simply as a great reservoir, and in that way the amount of water required to run such a canal would not be a tenth of what it is according to the Illinois system.

President.—The reason I asked that question was that I noticed a discussion a year or so ago as to the capacity of Lake Michigan to furnish the supply.

Campbell.—I can almost conceive of a diminution in Lake Michigan from that stream. It will almost be another Niagara out of Lake Michigan.

Carmichael.—I would like to ask Prof. Campbell if he has ever gone far into the economics of this question. There

is no question in the minds of anybody after hearing the paper and the explanation of the topography of the country and the ease with which physical difficulties can be overcome, but will it pay?

Campbell.—I don't think there is a more important economical question before the American people than that would be.

Carmichael.—It is an acknowledged fact that the Manchester Ship Canal will be a financial failure, so far as it benefits Manchester, and yet the cost of that canal would not be greater than the proposed canal.

Campbell.—We are expending a large sum on the Mississippi river, and wisely expending it, for whenever we give private corporations and railroad companies the entire control of the waters of this country, we fall into the hands of monopolists more than we have in the past. I don't wish to be understood as being against railroads, but it is very important that this country keep up its water ways. Now, if we can connect Lake Michigan with the Mississippi system, we will have solved an economic question whose magnitude cannot be conceived even. What I am afraid of is that if it should go to Congress, it would go into the hands of some one who knew nothing of it; but were it put into the hands of some one who was interested in it, who would look after it and see that it was put forward, I would then hope that something might come of it. We have not looked at these things from a selfish standpoint, if you please; we have a possibility in this work; we have a cause of personal character, which to Indiana, Kentucky and Illinois is of untold value. Then comes Chicago, which seeks outlets to the world. It is to be the great commercial center of this country next to New York City, and we don't want to be dependent on a single center. The trouble is now that the commerce of this country is too much dependent upon New York. If you can open up this line through such an improvement as this, you then place Chicago in a position aside New York.

Carmichael.—I move that a committee of three be appointed to take this matter in hand and to act, and that the President of this Society be chairman of said committee.

The President.—That motion is pretty nearly out of order. I suggest that Prof. Campbell be chairman of the committee.

Morrison.—I think the motion that was made to have our President chairman of that committee is exactly right, and it is a thing this Society ought to do.

Vice-President Goss.—Gentlemen of the Society, the motion is that a committee of three be appointed and the President of this Society be made chairman of that committee. Motion carried.

The President.—I will appoint as the other members of the committee W. P. Carmichael and E. B. Vawter.

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## SOME EXPERIENCES OF A CITY ENGINEER IN A SMALL CITY.

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BY C. G. H. GOSS, CITY ENGINEER OF MARTINSVILLE.

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If an engineer wishes to accumulate a large amount of peculiar experience, I know of no better plan to pursue than to have himself appointed City Civil Engineer in an old Indiana village, which, on account of some unexpected accident, finds itself suddenly started on the upgrade of prosperity and just budding into cityhood. The law authorizing his appointment is peculiar; the City Council which makes the appointment is peculiar; and, in fact, every circumstance surrounding his appointment is peculiar; but the most peculiar thing connected with the whole matter is, perhaps, the very peculiar idea that people generally have of the duties of the City Civil Engineer.

The city where the writer began his career of city engineering was an old timer, having been platted away back in the twenties; and when I say platted, I tell it all, for that



was all that was done. No monuments were put in; no stakes were driven; and from the best evidence obtainable, the land itself was not even measured. As lots were sold they were measured with a grapevine, stepped off, or guessed at. In early times potato patches and onion beds were more to be desired than streets and alleys, so all doubts as to measurement went in favor of the lots. When one man built a fence on his supposed lot line, his neighbor farther up the street sighted out his lot line by this fence; thus the first fence on a street determined, in a large measure, the direction of the lines of that street. These and other arbitrary proceedings were carried on while the town was passing through that uncertain stage when no one knew whether it would live or die.

One day the people of the county, in a fit of more than usual absentmindedness, elected a citizen of the village to represent them in that noted aggregation of modern philosophers, the Indiana legislature. This man was a long-headed patriot, and his sole qualification for a law-maker was his undisputed ability to do the wrong thing at exactly the wrong time. Many men having substantially the same qualification have been members of our general assembly in more recent times.

That portion of the people of our state that desires to be called the "yoemanry of the land," and whose ignorance and stupidity imposes upon itself a tax greater than that imposed by the authorities, would find in such a man a noble champion. It could always depend upon him to assist in keeping it in the servile and downtrodden condition which seems to be its normal state. All questions relating to the improvement of our common road system would be perfectly safe in the hands of such a man. This statesman thought he saw a danger signal ahead, and upon investigation he decided that the danger was, that his and numerous other villages in Indiana might eventually become large cities. He concluded that this danger might be averted, and that the best method of prevention was to

vacate as many as possible of the streets and alleys of these villages. He set to work and prepared a bill which made this vacation easy and expeditious.

The legislature, after carefully scrutinizing this bill and finding therein no mention of civil engineers, concluded that it must be about right and passed it, and it became a part of the law of the land. Immediately after the enactment of this law, the farmers adjoining the town purchased all the lots they could pay for, fenced them in with their lands and the larger part of the town became cornfields and cow pastures. The town struggled along, however, and grew slowly in spite of the inhabitants, until more room was needed. When these honest, horny-handed old grangers found that they could turn several good dollars by selling lots, they wished they were back in town, but they did not know exactly how to get there.

About this time, that mystery of mysteries, the County Surveyor, came upon the scene. If he had ever been here before he had carefully and thoroughly obliterated his tracks upon the scene. He was asked to lay off lots after the original plat of the town, and feeling at all times equal to any emergency, he proceeded to his task. When he walked out among the dogfennel in the old streets and drilled a hold in the ground with his jacobstaff, the small boys, and even the larger boys, yea, and even the old men looked upon him with a kind of reverence and awe that we, in our day, cannot quite understand. He traced his lines and turned off his angles by the needle, and measured his distances with a four rod chain that was anywhere from ten to eighteen inches too long. However, land was comparatively cheap, and if a lot was 68 x 136 feet instead of 66 x 132 feet, it was thought to be all right. If a man wished to build and did not have room enough on his lot, he went out into the street and took what he needed.

Time rolled on, and after the town had grown still larger, it was incorporated and run under a town government, and the Marshal was Street Commissioner. He was Street Com-

missioner, too, and he knew it as well as anybody. He was a graduate of the same great training school that furnishes the road supervisors for the State of Indiana, and like all of these gifted officials, he knew fully as much about everything else as he did about building streets and roads. This Street Commissioner and his successors succeeded in planning and putting in operation, a system of street building and drainage that was, at that time, the wonder and admiration of the entire community. Their street was a combination of the common mud road and a sweet-potato ridge, and their gutter was a compromise between a canal and a state ditch. They used an excessively large factor of safety in fixing the capacity of their drainage canals, and one of these canals was considered sufficient for each street. When a street was finished under their plans it was about like this: The canal occupied one half of the street and the excavated material from the canal was used to raise the remaining part of the street some two to four feet above the abutting lot level so that the roadway was sure to be above high water mark. In wet weather the street looked very much like an ordinary canal with the common toe-path attachment.

Their system of drainage also provided for evaporators. These evaporators were natural depressions or basins, of which there were quite a number in the town. They made a canal along a street until it reached one of these basins and there turned loose the water, where it remained until infiltration and evaporation removed it.

In 1866, the Town Board contracted with the County Surveyor to monument the center lines of the streets. This idea was all right, but Old Mystery failed and came far short of the glory of the profession. However, he put stones somewhere in the streets and the only fact shown by the records is that he drew his pay therefore. The town government continued until 1884, when, after due ceremony, it gave place to a city government.

The writer was present at the first meeting of the City Council and noted the expression of blank amazement upon

the countenances of the members when their attorney informed them that under the law they must appoint a City Civil Engineer. Upon consultation they thought it best to inquire for what purpose a City Engineer was needed. The attorney nobly confessed that he did not know of any possible use they would ever have for an Engineer, as he could think of nothing under the shining sun that an Engineer could do, but that the law directed that they appoint one and perhaps they should track the law in this instance, especially as it would not cost anything. One Councilman said "that he had been elected to this important office by the intelligent people of his ward to represent and protect their interests, and if he was assured that the appointment of a City Engineer would not conflict with the rights of his constituents to allow their cows, hogs and horses to run at large upon the streets of the city, he was willing to make the appointment." The attorney was pretty sure that a City Engineer would have no power to restrain the liberty of the live stock of the city; he thought the appointment was merely a matter of form and he was confident that the City Engineer would be allowed to exercise no authority at all and but a very limited amount of judgment and common sense in the management of city affairs. This explanation seemed to satisfy the Council and immediately they began to look about for some one to appoint. At length a member who had some sort of grudge against me, proposed my name and they proceeded to ballot. My popularity and the fact that there was no other candidate enabled me to poll the entire vote of the Council, and the Mayor declared me duly appointed City Engineer.

The next day, having some curiosity to know the position of a City Engineer in the eyes of the law, I consulted the statutes of the state. I found that the question of whether or not the Engineer was to be a figure-head only rested largely with the Common Council. About all the consolation I found was that the appointment would probably deprive the County Surveyor of the exquisite pleasure



of surveying the old crooked lot-lines of the city. I had no ill will against the County Surveyor, in fact, I had and still have a kind of miserable sympathy for him wherever I find him.

I held the office about six months, during which time I did no work and consequently drew no pay, for the Council had fixed the Engineer's wages at two dollars per day when he worked, and allowed him to do city work only when they ordered it. I had decided to change my place of residence and handed in my resignation, full of expression of regret and of thankfulness for the high and mighty honors conferred. The Council then appointed the County Surveyor to the vacant office, and once in history the "County Surveyor" proved equal to all requirements. The office at this time was held by George W. Pearce, a member of this society, now deceased, and I can do his memory no greater honor than to say that he was conscientious, painstaking and persevering in everything he undertook, fully and completely equipped and competent for any question that might arise. The first thing he did after his appointment was to convince the Council, which he did by an object lesson, that an Engineer's work was worth somewhat more money than it had expected to pay.

About the first systematic improvement undertaken, was the building of eight squares of brick sidewalks on as many different streets. All work done previous to this time had been paid for with funds from the general treasury, and when it was decided to compel the property owners to pay for building the walks abutting upon their property, a mighty howl went up, and some beautiful and artistic kicking was indulged in. The Engineer was ordered to stake out the work and advertise for bids. He asked to be allowed to establish grades upon all the streets upon which work was contemplated. This was refused, the Council saying that the city had gotten along remarkably well so far without grades and it was likely they could get on without them for quite awhile. They knew of no reason why an

Engineer should want a grade for a whole street from which to set one square of sidewalks. The Engineer explained, argued, begged, coaxed, demanded, and, in fact, exhausted all his resources without avail, and finally, in sheer desperation, went at the work and guessed out a grade for his walks.

Soon after the completion of these sidewalks Mr. Pearce died, and the office remained vacant quite a while, as there was no engineer then in the city, and outside engineers demanded as much as from five to eight dollars per day for their services while common laborers were receiving but one dollar and twenty-five cents per day. Then the writer again became a resident of the city and was at once appointed City Engineer. About this time the people residing in the vicinity of the evaporators became tired and disgusted with being overflowed every time it rained enough to start the water in the canals, and then they had gone on hauling and dumping mud and sand on the streets until the people sitting in their front yards had to look up at an angle of about thirty degrees to see a carriage on the street, and they began to complain about the streets being too high.

The Street Commissioner, who was an ex-road supervisor, contended that he was fully able to handle the street business without any help from the Engineer, so one day they set him to work to improve a street, and luckily, his field of operations lay in the most difficult part of the city to drain. This Street Commissioner was a hustler, when he worked he worked, and the first thing anybody knew, the citizens along that street were swearing and pulling their hair and cursing the Council, the Street Commissioner, and even the laborers on the work. The reason for the row was, that every man on the street had a plan of his own for the new street, and none of their plans were at all like the plan of the Street Commissioner. The Commissioner paid no attention, however, to this racket, and before the authorities could stop him, he had constructed a fairly good reservoir with ample capacity for a small water works plant.

The outlandish system of street work practiced had necessitated the putting in of numerous culverts and foot bridges, and they were all built of plank with wooden foundations. The life of these structures was from four to five years, and as there were about eight hundred of them in the city, their maintenance was a source of considerable expense. One day a bridge over one of the canals went down with a team and badly crippled both horses. The owner of the team brought suit against the city and had no trouble to procure judgment for the whole amount of the damage. The Council then undertook to investigate the bridge business and in their extremity asked the opinion of the City Engineer. He advised them to remove and dispense with the entire lot of the old traps. The advice alarmed the old settlers and they said, "our fathers built and used these bridges and we have used them, we cannot give them up; if they are removed the beauty and usefulness of the streets will be impaired."

The Engineer told them that if they would cut down the streets and put in curbing and make some common sense gutters the bridges would not be needed, and advised the Council to arrange for a huge excursion at the public expense, to take the people somewhere and compel them to look at a street. After awhile, the Council decided to take out a few bridges as an experiment, and ordered the Street Commissioner to remove about a dozen of the oldest ones. The Commissioner refused to obey the order, the old settlers having scared him out. This action of the Commissioner nettled the Council and they dispensed with his services, and appointed in his stead a man who they though knew just enough to obey orders. This new Commissioner took out the bridges as ordered, and the job suited him so well that he kept up the good work without orders, and during the first month of his campaign he took out about four hundred of them. The old settlers howled loud and long, the Council was mad, and the Engineer made them furious by proposing to raise a fund by popular subscription to build

a monument to the man who had nerve enough to tear out the bridges. It required considerable time for the idea to work through the skulls of the old settlers, but at last it got through and they acknowledged that the taking out of the bridges was a great success. This admission was considered by the Engineer somewhat in the nature of a victory, and he duly thanked the hard-headed Street Commissioner who made its achievement possible.

Shortly after this, the Council ordered the Engineer to prepare and present plans, specifications and estimates for the improvement of a street\* (the worst one in the city) down which a lively spring branch wound its way to a state ditch. This was the Engineer's opportunity to impress the Council and he took advantage of it. His plans provided for a modern brick paved roadway, with first-class curbing and cement sidewalks. He proposed to carry the branch and storm water under the street in a sewer so constructed that it could become a part of any system of sewerage that might in the future be adopted.

At the next meeting of the Council, the Engineer was there with his plans, specifications and estimates. He had decided to hold the estimates to the very last moment, not knowing the exact effect they would have upon the members. At the proper time, he spread the profile upon a table and asked the Councilmen to inspect it. After they had looked at it some time, one member remarked that "He always knew that the street was crooked, but it was surely not so crooked as that black line showed it to be." Then it required fully half an hour to convince that man that the black irregular line on the profile represented the vertical and not the horizontal crookedness of the street. Before beginning the survey for this street, the Engineer had put in a good stone to be used as a permanent bench or standard level, and had established and recorded, a datum one hundred feet below the top of this stone, to which he could refer all of the grades in the city, and in the explanation of the profile, he thoughtlessly mentioned something about



this city datum. This remark precipitated more debate and required more explanation, and finally they agreed that they could not understand it at all, and could see no earthly use for such a thing in connection with the matter in hand. The Engineer then explained the plans for the street, urging in the best language at his command, the desirability of the improvement and the final economy of making it according to his plans.

His explanation of the plans and his description of the finished street seemed to be very satisfactory to the Council, and just at the time when he thought things were coming his way with a rush, some one asked for the estimate of the cost of the work. It was given and the effect carefully noted. Some of them gasped for breath; others grasped their chair-arms to keep from falling, and still others threw up their hands in a sort of helpless, hopeless way that was unpleasant to behold. As soon as they recovered somewhat from their bewilderment and got right down to business, they killed the project as dead as the historical door nail in about one minute, and the engineer gathered together his plans, profile and estimates, folded them carefully and wrote upon the back thereof, "The first sensible attempt at street building in this city. Died a violent death at the hands of the Common Council, September 7, 1889. It appeared as one born out of due time."

Finally, the people generally began to realize the fact that it was all well enough to have one or two watch-dogs of the treasury on duty, but that a City Council composed entirely of watch-dogs was not desirable. After this a great change was noticeable in the "drift cast up by the waves after the annual political storms." The change was not abrupt, but it was sure. The Engineer was consulted; his ideas and judgment began to be worth something; he was employed and paid for his work, and those who furnished the sinews of war began to see some returns. Public opinion regarding city improvements has changed materially for the better. The city has improved much and the City Engineer has improved some.

Now, instead of fighting every enterprise suggested, the people are demanding improvements, the making of which is far beyond the present ability of the city. True, we still have some veteran kickers and croakers, the kind that brother John T. Campbell would call "setting hens and mud turtles," but their influence is limited and their occupation is almost gone.

In conclusion I wish to say, that if any of my hearers ever begin as I did, in a regular old "way back" settlement, and undertakes to educate the entire community, he will have tackled a job the size of which can be estimated only approximately.

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### SOME EXPERIMENTS TO DETERMINE THE EFFECT OF BEDDING UPON THE STRENGTH OF MARBLE.

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BY MALVERD A. HOWE.

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It is a well recognized fact that it is very difficult to obtain uniform results in testing specimens of stone in compression, even when great care is exercised in preparing the specimens and in placing them in the testing machine. This is mainly due to the inability of workmen making the bearing faces of the specimens true parallel planes without special machinery or great expense. For commercial purposes, it is necessary that some means be devised by which reliable results can be obtained with specimens formed by tools and machinery usually found at stone works of any considerable magnitude, to enable the engineer to obtain a definite knowledge of the strength of the stone in compression, which he intends to use, without going to great expense and consuming much time. This does not necessarily mean that the results of the experiments shall represent the strength of the material in large pieces, as used in engineering structures, but that they shall represent the comparative strength of the material, some well known homogeneous stone being taken as a standard.



If specimens are formed by ordinary tools and machinery, the faces will usually have ridges and high points (see remarks under tables I to V, inclusive), and are seldom parallel; when such a specimen is placed in the testing machine, it will first take the applied load on the high points and ridges; as the pressure is increased, these will be crushed down and the specimen fails by being wedged apart, if the term wedge may be applied to the portions of the specimen which have the uncommon loads.

The specimen may be artificially "trued up" in several ways, the most common way being, perhaps, to cover the bearing faces with plaster paris, which can be either cast so as to present true parallel planes, or ground to such a state. Another method is to place between the bearing faces of the specimen and the faces of the testing machine some material which will, or rather is supposed to, conform to the irregularities of the specimen, and distribute the applied load uniformly over the bearing faces. Sheet lead, sole leather and pine have been employed for this purpose, but as far as the writer is informed none of them has been used to any great extent. In order to determine, if possible, something about the effect of bedding upon the results of compression tests, and also their reliability, the writer had a series of specimens prepared at a marble quarry in Iowa, under the following specifications:

1st. Specimens to have square bases and a height equal to one and one-half the side of the base.

2d. For any particular grade of stone, the specimens representing that grade to be cut from the same piece of stone.

3d. Specimens to be cut so that the natural bed of the stone would form the square bases.

The specimens were cut by ordinary tools and machinery. Five grades of stone were represented by the specimens which were of two sizes, one set being  $3" \times 3" \times 4\frac{1}{2}"$  and the other  $2" \times 2" \times 3"$ . The specimens were received wrapped in paper and packed in sawdust, which was found to be very damp when the specimens were unpacked, April 7th, 1893, and placed near a steam coil, where they remained until tested.

The writer decided to try five kinds of bedding material, namely, cast iron, soft pine, sole leather, sheet lead and tar board. Plaster paris was not tried owing to the unknown effect of the moisture necessarily absorbed by the stone and the undesirability of using such a material in commercial work. The cast iron employed was in the shape of a rectangular block, having true and parallel bearing faces; the soft pine was thoroughly seasoned pieces about  $4" \times 9" \times \frac{1}{4}"$ ; the sole leather was perfectly dry and the pieces were just a little larger than the bearing face of the specimen; the sheet lead was in pieces  $4" \times 4"$ , as were also the pieces of tar board. In each case one piece of bedding material was used on each bearing face of the specimen and in no case was any piece used twice.

As the specimens were tested, they were carefully measured, two measurements being taken to determine the area of each bearing face and four to determine the distance between these faces. The specimens were also examined for chips, cracks, ridges, high points, etc. (See remarks under tables I to V, inclusive.) In placing the specimens in the testing machine, care was exercised to have the plates transmitting the pressure bear, as nearly as possible, over the entire face of the specimen by means of thin iron wedges. The specimens were closely watched for the first crack or signs of failure. In all cases the load was slowly applied.

Tables I to V, inclusive, give the principal results of the experiments.

Column 1 indicates the reference number.

Column 2 gives the date of the experiment in the year 1893.

Column 3 contains the mark and the grade of the specimen.

Column 4 gives the nominal dimensions of the specimen,

Column 5 the area of the specimen.

Column 6 the load under which the specimen commenced failing.

Column 7 the maximum load sustained.

Column 8 the strength per square inch, based upon the results given in columns 5 and 7.

Column 9 the average thickness of the bedding material.

Under the head of Remarks is given the general characteristics of the end faces of the specimen and the character of the failure.

Table A gives the average unit strengths of the different sizes and grades when tested with different bedding materials.



Table B gives the average unit strengths of the different sizes and grades without regard to the kind of bedding materials employed, and also the average unit strength of each grade.

Table C gives the relative magnitudes of the results for each grade, size and bedding material.

Table D gives the relative values of the bedding material, as measured by the relative magnitudes of the results given in Table C.

Table E gives the relative values of the bedding material, as measured by Table D.

#### SUMMARY OF RESULTS.

*Cast Iron Bed.*—Out of twenty-six specimens, six cracked before the maximum load was reached. Fourteen out of twenty-four failures left two pyramids. From Table E it is seen that the average results stand fifth in magnitude. These results indicate that the specimens were tested under very nearly the same conditions, and also that the specimens were not sufficiently true to give reliable results, as about forty per cent. of the failures indicate a non-uniformity in the application of the pressure by failing in pieces wedge-shaped, etc., instead of pyramids.

*Soft Pine Bed.*—Here only two specimens out of seventeen cracked before the maximum load was applied, but in only five cases were two pyramids obtained, the specimens having a tendency to split on lines parallel with the grain of the pine. The specimens usually compressed the pine about  $\frac{1}{8}$ " and hence was confined at the edges; this, with the more uniform distribution of the pressure, is probably the explanation of the increased magnitude of the results obtained, the results standing third in Table E.

*Sole Leather Bed.*—Three specimens out of nine cracked before failure and three specimens left two pyramids, the remaining specimens leaving wedges or small pieces. The specimen compressed the leather a little, which evidently caused the specimens to be confined slightly at the edges. The leather probably had a tendency to distribute the pressure over the face of the specimen, but evidently this distribution was not uniform, as only three of the specimens left two pyramids. This may possibly be explained by the fact that the sole leather was not uniform in thickness, commercial leather being employed. The results obtained stand second in magnitude.

*Sheet Lead Bed.*—Here no specimens cracked before receiving the maximum load, and eight out of ten specimens left two pyramids. The lead was uniform in thickness and after the experiment was but slightly compressed. The results stood fourth in magnitude. The indication were that the lead distributed the pressure very evenly, but lowered the magnitude of the results by, probably, flowing into the specimen and wedging it apart.

*Tar Board Bed.*—Three specimens out of fifteen cracked before receiving the maximum load, and ten out of fifteen left two pyramids. The tar board was of uniform thickness and slightly compressed after the experiment; the specimen was probably confined somewhat at the edges. The results stand first in magnitude, which is probably due somewhat to the confining action of the tar board and to the even distribution of the pressure applied.

#### CONCLUSIONS.

In conclusion, it appears to the writer that to obtain the best idea of the comparative strengths of specimens of different kinds of stone, the specimens should be cut with perfectly parallel plane ends and tested between parallel iron or steel plates. But this calls for great labor and expense in preparing the specimens so that some kind of bedding material seems desirable. Of those tried, sheet lead seems to distribute the pressure the best, but lowers the strength of the specimen by an unknown amount, depending upon the structure of the material. Pine is undesirable owing to its splitting action. Sole leather answers very well, but has the objection of not being uniform in thickness. Tar board distributes the pressure very well, does not flow into the specimen, has no uplifting action, but raises the strength of the specimen by confining the ends; yet in spite of the latter defect, the writer believes, for commercial testing or comparative tests, that it is the most reliable of the five kinds of bedding material tried.

This conclusion is based upon but eighty specimens, but a careful examination of the detailed results as given in Tables I to V, inclusive, shows that the specimens were practically

uniform in respect to the characteristics of their end faces, and as each grade was cut from the same piece of stone, it is believed the conclusion is warranted.

Negotiations are in progress for a large number of specimens for compressive and cross-breaking tests, to be cut from the same piece of stone, to see if there is any definite relation between the cross-breaking and compression strengths of the material, or if the cross-breaking results are reliable. If it is found that the cross-breaking results are reliable, then such tests may be substituted for the compressive tests, thereby materially decreasing the labor and expense of preparing specimens and testing them.

The writer is under obligations to the Le Grand Quarry Co., of Marshalltown, Iowa, through whose courtesy the specimens used in the above experiments were obtained.

### CAST IRON BED.

TABLE I.

| 1  | 2        | 3   | 4      | 5    | 6     | 7       | 8      | 9     |
|----|----------|-----|--------|------|-------|---------|--------|-------|
| 1  | April 7  | 1 A | 2x2x3  | 4.02 | 28300 | 46800   | 11640  | ..... |
| 2  | "        | 1 B | "      | 3.96 | 15000 | 17750   | 4480   | ..... |
| 3  | "        | 1 C | "      | 4.16 | 15200 | 15200   | 3650   | ..... |
| 4  | "        | 1 D | "      | 4.16 | 20800 | 23200   | 5580   | ..... |
| 5  | "        | 1 E | "      | 4.10 | 14400 | 14400   | 3510   | ..... |
| 6  | April 25 | 6 A | "      | 4.06 | 56100 | 56100   | 13810  | ..... |
| 7  | "        | 6 B | "      | 4.00 | 21000 | 21000   | 5200   | ..... |
| 8  | "        | 6 C | "      | 3.98 | 19000 | 19000   | 4780   | ..... |
| 9  | "        | 6 D | "      | 3.99 | 22300 | 22300   | 5590   | ..... |
| 10 | "        | 6 E | "      | 4.11 | 25600 | 25600   | 6250   | ..... |
| 11 | April 7  | 1 A | 3x3x4½ | 8.94 | 44000 | 74800   | 8370   | ..... |
| 12 | "        | 1 B | "      | 8.94 | 37600 | 37600   | 4210   | ..... |
| 13 | "        | 1 C | "      | 9.03 | 25300 | 25300   | 2800   | ..... |
| 14 | "        | 1 D | "      | 9.14 | 54100 | 54100   | 5920   | ..... |
| 15 | "        | 1 E | "      | 9.03 | 39000 | 47800   | 5290   | ..... |
| 16 | April 25 | 6 A | "      | 9.09 | No    | Failure | 11000+ | ..... |
| 17 | "        | 6 B | "      | 9.15 | 61200 | 61200   | 6690   | ..... |
| 18 | "        | 6 C | "      | 9.09 | 50200 | 50200   | 5320   | ..... |
| 19 | "        | 6 D | "      | 9.23 | 80750 | 80750   | 8750   | ..... |
| 20 | "        | 6 E | "      | 8.95 | 45200 | 45200   | 5050   | ..... |
| 21 | May 2    | 9 A | "      | 9.15 | No    | Failure | 10930+ | ..... |
| 22 | "        | 9 B | "      | 9.00 | 63000 | 63000   | 7000   | ..... |
| 23 | "        | 9 C | "      | 8.91 | 41400 | 42800   | 4800   | ..... |
| 24 | "        | 9 E | "      | 8.88 | 68300 | 68300   | 7690   | ..... |
| 25 | "        | 9 D | 2x2x3  | 3.52 | 13600 | 13600   | 3860   | ..... |
| 26 | "        | 9 E | "      | 3.65 | 18600 | 18600   | 5090   | ..... |

## REMARKS.

- 1 Small crown in center of each end face; 2 pyramids; bottom split into many pieces.
- 2 High on edges and in center of end faces; 1 pyramid, 1 wedge. When load of 15,000 was reached, a small crack from top to bottom in front face appeared.
- 3 High in centers; one corner slightly chipped; 1 pyramid, 1 wedge.
- 4 Ends nearly plane; one pyramid from top.
- 5 High in centers.
- 6 Small crown in center of each face; 2 small pyramids, poor; specimen exploded.
- 7 Hollow in top face, bottom face plane; large chip off one corner; rough on top and bottom; 2 pyramids, not very good.
- 8 Top and bottom faces plane; small chips off 3 corners; 2 good pyramids.
- 9 Top and bottom faces plane, rough on both faces; 2 edges slightly chipped; 2 very poor pyramids; top pyramid large.
- 10 Top face plane; ridge on bottom face; small chip off one corner and one edge. Failed by shearing.
- 11 Small crown in center of each end face; 1 crack, 2 wedges.
- 12 Small crown in center of each end face; long bottom wedge, nothing at top.
- 13 Small crown in center of each end face; 2 good pyramids; pyramids very nearly equal.
- 14 Small crown in center of each end face; 2 pyramids, the bottom one the larger.
- 15 Small crown in center of each end face; 1 crack, 1 pyramid at top.
- 16 Small crown in center of each end face; small chip off one corner. No failure; 100,000 pounds applied.
- 17 Small crown in center of each end face; 2 good pyramids.
- 18 Small crown in center of each end face; small chips off three top corners; 2 good pyramids.
- 19 Small crown in center of each end face; 2 pyramids; one good, one small.
- 20 Small crown in center of each end face; 2 poor pyramids; specimens did not have an even bearing.
- 21 Small crown in center of each end face. No failure; 100,000 pounds applied.
- 22 Small crown in center of each end face; 2 good pyramids.
- 23 Small crown in center of each end face; 2 good pyramids.
- 24 Small crown in center of each end face; chip off one corner; 2 pyramids, not very good.
- 25 Small crown in center of each end face; non-regular pieces.
- 26 Small crown in center of each end face; failed by shear.



## SOFT PINE BED.

TABLE II.

| 1  | 2       | 3   | 4      | 5    | 6     | 7       | 8      | 9    |
|----|---------|-----|--------|------|-------|---------|--------|------|
| 27 | April 8 | 2 A | 2x2x3  | 3.92 | 47400 | 51100   | 13040  | 0.25 |
| 28 | "       | 2 B | "      | 3.91 | 23700 | 23700   | 6070   | 0.25 |
| 29 | "       | 2 C | "      | 4.08 | 20700 | 20700   | 5070   | 0.25 |
| 30 | "       | 2 D | "      | 4.08 | 25100 | 25100   | 6150   | 0.25 |
| 31 | "       | 2 E | "      | 4.05 | 22300 | 22300   | 5510   | 0.25 |
| 32 | "       | 2 A | 3x3x4½ | 9.22 | 78900 | 78900   | 8560   | 0.25 |
| 33 | "       | 2 B | "      | 9.06 | 44300 | 47000   | 5190   | 0.25 |
| 34 | "       | 2 C | "      | 8.90 | 31800 | 31800   | 3580   | 0.25 |
| 35 | "       | 2 D | "      | 9.00 | 61350 | 61350   | 6820   | 0.25 |
| 36 | "       | 2 E | "      | 8.79 | 55100 | 55100   | 6270   | 0.25 |
| 37 | May 2   | 7 A | "      | 9.21 | No    | Failure | 10860+ | 0.25 |
| 38 | "       | 7 B | "      | 8.97 | 60400 | 60400   | 6730   | 0.25 |
| 39 | "       | 7 C | "      | 8.93 | 43000 | 43000   | 4820   | 0.25 |
| 40 | "       | 7 D | "      | 8.86 | 72900 | 72900   | 8230   | 0.25 |
| 41 | "       | 7 E | "      | 8.92 | 67300 | 67300   | 7540   | 0.25 |
| 42 | "       | 7 A | 2x2x3  | 3.93 | 60900 | 60900   | 15490  | 0.25 |
| 43 | "       | 7 D | "      | 4.04 | 30800 | 30800   | 7620   | 0.25 |
| 44 | "       | 7 E | "      | 3.92 | 24100 | 24100   | 6150   | 0.25 |

## REMARKS.

- 27 Top and bottom faces slightly crowned. When loaded with 47,400 pounds, specimen cracked; 1 wedge, 1 pyramid.
- 28 No record; 2 poor pyramids.
- 29 Top and bottom faces slightly crowned; 2 good pyramids.
- 30 Ridge in top face, bottom plane; no record.
- 31 Deep tool marks in top face, bottom high in center. Failed by shearing.
- 32 Top face plane, bottom had deep tool marks; 2 pyramids; first chip came off from side parallel to grain of pine bedding; pine split when specimen failed.
- 33 Top face plane, corner chipped 1" x ½"; bottom high in center; corner chipped ½" x ¼"; at load 4430 one bottom corner failed, two poor pyramids.
- 34 Top and bottom faces high in the center; one corner chipped ¼" x ½"; 1 wedge at top; 1 V at bottom.
- 35 Top face slightly crowned in center, bottom face plane; top broke into small pieces; 1 bottom pyramid.
- 36 Top and bottom faces slightly crowned; top broke into small pieces; 1 wedge at bottom.
- 37 Both end faces slightly crowned. No record.
- 38 Both end faces faces slightly crowned; triangular pyramids at top and bottom.
- 39 Both end faces slightly crowned; at load of 43,000 pounds, chips came off corner; 2 thin wedges.

- 40 Both end faces slightly crowned; no good pyramids, many pointed pieces.
- 41 Both ends slightly crowned; chip off one corner; 1 large wedge from top, many pieces from bottom.
- 42 Both ends slightly crowned; 1 bottom wedge, 2 top wedges.
- 43 Both ends slightly crowned; 1 top wedge, 2 bottom wedges.
- 44 Both ends slightly crowned. Failed by shear.

## SOLE LEATHER BED.

TABLE III.

| 1  | 2        | 3   | 4      | 5    | 6     | 7       | 8      | 9    |
|----|----------|-----|--------|------|-------|---------|--------|------|
| 45 | April 14 | 3 A | 2x2x3  | 4.02 | 49400 | 59800   | 14870  | 0.17 |
| 46 | "        | 3 B | "      | 3.96 | 28000 | 28000   | 7070   | 0.15 |
| 47 | "        | 3 C | "      | 3.94 | 20400 | 20400   | 5180   | 0.17 |
| 48 | "        | 3 D | "      | 4.10 | 26700 | 29100   | 7090   | 0.17 |
| 49 | "        | 3 E | "      | 4.06 | 23500 | 23500   | 5790   | 0.15 |
| 50 | "        | 3 A | 3x3x4½ | 9.24 | No    | Failure | 10800+ | 0.15 |
| 51 | "        | 3 B | "      | 9.08 | 48500 | 48500   | 5340   | 0.11 |
| 52 | "        | 3 C | "      | 9.03 | 29800 | 34000   | 3760   | 0.11 |
| 53 | "        | 3 D | "      | 9.12 | 67250 | 67250   | 7370   | 0.14 |
| 54 | "        | 3 E | "      | 8.97 | 67000 | 67000   | 7470   | 0.19 |

## REMARKS.

- 45 Slightly crowned in center of top face; bottom plane. At load of 49,400 pounds chip came off one corner; top wedge, bottom V.
- 46 Top and bottom faces high in center; top wedge; bottom, four prongs at corners.
- 47 Top and bottom faces high in centre; poor pyramids at top and bottom.
- 48 Slight crown in center of top; bottom plane. At load of 26,700 pounds, corner failed; top wedge, bottom V.
- 49 Slight crown in center of top face; bottom plane; 2 pyramids, bottom small,
- 50 Both ends slightly crowned in center. No failure; 100,000 pounds applied.
- 51 Both ends slightly crowned in center; 1 top pyramid.
- 52 Both ends slightly crowned in center. At load of 29,800 pounds cracked; imperfect pyramid at top and imperfect wedge at bottom.
- 53 Both ends slightly crowned in center; large pyramid at top, small pyramid at bottom.
- 54 Both ends slightly crowned in center; small chip off one corner; 1 wedge at top, 1 small pyramid at bottom; many small pieces.

## TAR BOARD BED.

TABLE IV.

| 1  | 2        | 3   | 4      | 5    | 6     | 7       | 8      | 9    |
|----|----------|-----|--------|------|-------|---------|--------|------|
| 55 | April 15 | 4 A | 2x2x3  | 4.00 | 63200 | 63200   | 15800  | 0.12 |
| 56 | "        | 4 B | "      | 3.96 | 21800 | 21800   | 5510   | 0.12 |
| 57 | "        | 4 C | "      | 4.00 | 21200 | 21200   | 5300   | 0.12 |
| 58 | "        | 4 D | "      | 4.04 | 26950 | 30200   | 7470   | 0.12 |
| 59 | "        | 4 E | "      | 4.06 | 24500 | 24500   | 6030   | 0.12 |
| 60 | "        | 4 A | 3x3x4½ | 9.08 | 89800 | 97700   | 10760  | 0.12 |
| 61 | "        | 4 B | "      | 8.94 | 63600 | 63600   | 7110   | 0.12 |
| 62 | "        | 4 C | "      | 8.97 | 35700 | 35700   | 3980   | 0.12 |
| 63 | "        | 4 D | "      | 8.97 | 56000 | 62500   | 6970   | 0.12 |
| 64 | "        | 4 E | "      | 9.03 | 69800 | 69800   | 7730   | 0.12 |
| 65 | May 2    | 8 A | "      | 9.03 | No    | Failure | 11070+ | 0.12 |
| 66 | "        | 8 B | "      | 9.21 | 69300 | 69300   | 7520   | 0.12 |
| 67 | "        | 8 C | "      | 9.02 | 45700 | 45700   | 5070   | 0.12 |
| 68 | "        | 8 D | "      | 8.61 | 80800 | 80800   | 9380   | 0.12 |
| 69 | "        | 8 D | 2x2x2  | 4.08 | 33000 | 33000   | 8090   | 9.12 |
| 70 | "        | 8 E | "      | 3.73 | 20200 | 20200   | 5410   | 0.12 |

## REMARKS.

- 55 Top and bottom faces high in center. At load of 58,600 pounds numerous flakes dropped from specimen; 2 poor pyramids.
- 56 Top face hollow in center, bottom plane. At load of 21,800 pounds, large chip came off side and corner; 1 pyramid at top, 4 prongs at bottom.
- 57 Top and bottom faces high in center; 2 pyramids.
- 58 Top face slightly crowned in center, marked crown in bottom face, with ridge running perpendicular to sides. At load of 26,950 pounds, signs of failure appeared at bottom edges; bottom failed on line of ridge.
- 59 Top and bottom faces high in center; 2 pyramids.
- 60 Top face high in center, bottom face high in center. At load of 89,800 pounds, a small crack appeared at one corner; large pyramid at top, small pyramid at bottom. Specimen exploded, tearing bedding at corner. Specimen did not have even bearings, judging by impressions left in bedding.
- 61 Top and bottom faces high in center; 2 poor pyramids; exploded.
- 62 Top and bottom faces high in center, one corner low; 2 corners of sides blown out, remaining 2 cracked.
- 63 Top face plane, bottom face high in center; faces not parallel. At load of 56,000 pounds, crack appeared at one corner; failed by sheer; 1 wedge at top.
- 64 Top and bottom faces high in center; 1 good pyramid at top, 1 poor pyramid at bottom.

- 65 Top and bottom faces high in center; small chip off one corner.  
No failure; 100,000 pounds applied.
- 66 Top and bottom faces high in center; small chip off corner; 2  
pyramids.
- 67 Top and bottom faces high in center; 2 not very good pyramids.
- 68 Top and bottom faces high in center; small chip off corner; 2  
good pyramids; 3 sides of specimen blown out of machine.
- 69 Top and bottom faces high in center; wedge action caused failure.
- 70 Top and bottom faces high in center. Failed by shear.

## SHEET LEAD BED.

TABLE V.

| 1  | 2        | 3   | 4      | 5    | 6     | 7     | 8     | 9    |
|----|----------|-----|--------|------|-------|-------|-------|------|
| 71 | April 22 | 5 A | 2x2x3  | 4.06 | 54000 | 54000 | 13300 | 0.04 |
| 72 | "        | 5 B | "      | 3.90 | 23700 | 33700 | 6080  | 0.04 |
| 73 | "        | 5 C | "      | 4.08 | 21200 | 21200 | 5190  | 0.04 |
| 74 | "        | 5 D | "      | 3.96 | 18700 | 18700 | 4720  | 0.04 |
| 75 | "        | 5 E | "      | 4.00 | 19600 | 19600 | 4900  | 0.04 |
| 76 | "        | 5 A | 3x3x4½ | 9.03 | 93200 | 93200 | 10320 | 0.04 |
| 77 | "        | 5 B | "      | 9.03 | 60750 | 60750 | 6730  | 0.04 |
| 78 | "        | 5 C | "      | 9.00 | 33900 | 33900 | 3770  | 0.04 |
| 79 | "        | 5 D | "      | 8.82 | 62200 | 62200 | 7050  | 0.04 |
| 80 | "        | 5 E | "      | 9.18 | 63900 | 62900 | 6850  | 0.04 |

## REMARKS.

- 71 Top and bottom faces high in center; 2 small pyramids; leads broken.
- 72 Top and bottom faces high in center; cracked and then slowly failed; 2 pyramids; both leads broken.
- 73 Top and bottom faces high in center; 2 good pyramids.
- 74 Top and bottom faces high in center. Failed without noise; 2 poor pyramids.
- 75 Top and bottom faces high in center; 1 pyramid at top.
- 76 Top and bottom faces high in center; 2 pyramids; both leads broken.
- 77 Top and bottom faces high in center. At load of 60,750 pounds specimen commenced failing, then went to pieces in a few seconds; 2 good pyramids; both leads broken.
- 78 Top and bottom faces high in center. Cracked and then failed in about 60 seconds; 2 fair pyramids.
- 79 Top and bottom faces high in center. Failed same as 75.
- 90 Top and bottom faces high in center; 2 pyramid; bottom lead broken.



TABLE A.

The average strengths per square inch of the various grades as attained with the different kinds of bedding. Results of eighty experiments.

| Size and Grade of Specimen. | CHARACTER OF BEDDING. |                    |                    |                    |                    |
|-----------------------------|-----------------------|--------------------|--------------------|--------------------|--------------------|
|                             | Cast Iron.            | Soft Pine.         | Sole Leather.      | Tar Board.         | Sheet Lead.        |
| 2x2x3                       | 12700 <sup>2</sup>    | 14200 <sup>2</sup> | 14900 <sup>1</sup> | 15800 <sup>1</sup> | 13300 <sup>1</sup> |
| 3x3x4½                      | 10100 <sup>3</sup>    | 9700 <sup>2</sup>  | 10800 <sup>1</sup> | 10900 <sup>2</sup> | 10320 <sup>1</sup> |
| A mean                      | 11200                 | 12000              | 12900              | 12600              | 11800              |
| 2x2x3                       | 4900 <sup>2</sup>     | 6100 <sup>1</sup>  | 7100 <sup>1</sup>  | 5500 <sup>1</sup>  | 6100 <sup>1</sup>  |
| 3x3x4½                      | 6000 <sup>3</sup>     | 6000 <sup>2</sup>  | 5300 <sup>1</sup>  | 7300 <sup>2</sup>  | 6700 <sup>1</sup>  |
| B mean                      | 5500                  | 6000               | 6200               | 6700               | 6400               |
| 2x2x3                       | 4200 <sup>2</sup>     | 5100 <sup>1</sup>  | 5200 <sup>1</sup>  | 5300 <sup>1</sup>  | 5200 <sup>1</sup>  |
| 3x3x4½                      | 4400 <sup>3</sup>     | 4200 <sup>2</sup>  | 3800 <sup>1</sup>  | 4500 <sup>2</sup>  | 3800 <sup>1</sup>  |
| C mean                      | 4300                  | 4500               | 4500               | 4800               | 4500               |
| 2x2x3                       | 5000 <sup>3</sup>     | 6900 <sup>2</sup>  | 7100 <sup>1</sup>  | 7800 <sup>2</sup>  | 4700 <sup>1</sup>  |
| 3x3x4½                      | 7400 <sup>3</sup>     | 7500 <sup>2</sup>  | 7400 <sup>1</sup>  | 8200 <sup>2</sup>  | 7100 <sup>1</sup>  |
| D mean                      | 6200                  | 7200               | 7300               | 8000               | 5900               |
| 2x2x3                       | 4900 <sup>3</sup>     | 5800 <sup>2</sup>  | 5800 <sup>1</sup>  | 5700 <sup>2</sup>  | 4900 <sup>1</sup>  |
| 3x3x4½                      | 5200 <sup>2</sup>     | 6900 <sup>2</sup>  | 7500 <sup>1</sup>  | 7700 <sup>1</sup>  | 6900 <sup>1</sup>  |
| E mean                      | 5000                  | 6400               | 6700               | 6400               | 5000               |

The small figures at the right and above the numbers denoting the unit strength, represent the number of results combined in obtaining this unit strength.

TABLE B.

The average strength per square inch of different grades of specimens without regard to kind of bedding. Results of eighty experiments.

| SIZE.  | GRADE.              |                    |                    |                    |                    |
|--------|---------------------|--------------------|--------------------|--------------------|--------------------|
|        | A                   | B                  | C                  | D                  | E                  |
| 2x2x3  | 14000 <sup>7</sup>  | 5800 <sup>6</sup>  | 4900 <sup>6</sup>  | 6300 <sup>9</sup>  | 5400 <sup>9</sup>  |
| 3x3x4½ | 10300 <sup>9</sup>  | 6300 <sup>9</sup>  | 4300 <sup>9</sup>  | 7600 <sup>9</sup>  | 6600 <sup>7</sup>  |
| Total  |                     |                    |                    |                    |                    |
| Mean.. | 11900 <sup>16</sup> | 6108 <sup>15</sup> | 4500 <sup>15</sup> | 6900 <sup>18</sup> | 5900 <sup>16</sup> |

The small figures above and to the right indicate the number of results combined.

TABLE C.

The relative strengths of the various grades when tested with different kinds of bedding material as indicated by the results in Table A. 1 represents the maximum average for any particular size and grade.

| Grade and Dimensions. | CHARACTER OF BEDDING. |            |               |            |             |
|-----------------------|-----------------------|------------|---------------|------------|-------------|
|                       | Cast Iron.            | Soft Pine. | Sole Leather. | Tar Board. | Sheet Lead. |
| A                     |                       |            |               |            |             |
| 2x2x3                 | 5                     | 3          | 2             | 1          | 4           |
| 3x3x4½                | 4                     | 5          | 2             | 1          | 3           |
| B                     |                       |            |               |            |             |
| 2x2x3                 | 5                     | 2 and 3    | 1             | 4          | 2 and 3     |
| 3x3x4½                | 3 and 4               | 3 and 4    | 5             | 1          | 2           |
| C                     |                       |            |               |            |             |
| 2x2x3                 | 5                     | 4          | 2 and 3       | 1          | 2 and 3     |
| 3x3x4½                | 2                     | 3          | 4 and 5       | 1          | 4 and 5     |
| D                     |                       |            |               |            |             |
| 2x2x3                 | 4                     | 3          | 2             | 1          | 5           |
| 3x3x4½                | 3 and 4               | 2          | 3 and 4       | 1          | 5           |
| E                     |                       |            |               |            |             |
| 2x2x3                 | 4 and 5               | 1 and 2    | 1 and 2       | 3          | 4 and 5     |
| 3x3x4½                | 5                     | 3 and 4    | 2             | 1          | 3 and 4     |

TABLE D

The relative value of various kinds of bedding material as indicated by the number of average results having the relation of first, second, etc. First representing the maximum average.

| Relative<br>Strengths. | CHARACTER OF BEDDING. |               |                  |               |                |
|------------------------|-----------------------|---------------|------------------|---------------|----------------|
|                        | Cast<br>Iron.         | Soft<br>Pine. | Sole<br>Leather. | Tar<br>Board. | Sheet<br>Lead. |
| First.....             | 0                     | 1             | 2                | 8             | 0              |
| Second.....            | 1                     | 3             | 6                | 0             | 3              |
| Third.....             | 2                     | 6             | 2                | 1             | 4              |
| Fourth.....            | 5                     | 3             | 2                | 1             | 4              |
| Fifth.....             | 5                     | 1             | 2                | 0             | 4              |

TABLE E.

The relative value of the various kinds of bedding material as indicated by the relative magnitudes of the average unit strengths of the material. First, representing the maximum average unit strength.

TAR BOARD.

FIRST.

SOLE LEATHER.

SECOND.

SOFT PINE.

THIRD.

SHEET LEAD.

FOURTH.

CAST IRON.

FIFTH.

## A STATE BRIDGE ENGINEER.

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BY WALLACE MARSHALL.

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There has been an impression among a part of the engineers of the State for years, that there should be some change in the laws of the State concerning the erection and maintaining of public bridges. So far as I have been informed, there has never been any concerted action or unanimity of opinion as to what is required. However, it seems to be conceded generally, by the engineers, both practicing and contracting, that a higher grade should be established for the highway bridges. The public does not demand any changes. Why? Because the public is ignorant of the entire subject. During the session of the Indiana legislature of 1893, there was a measure introduced, known as the Wishart Bill, for enactment into law. Mr. Wishart was not the author of the bill any more than our beloved Johnny McHugh was the author of the Roby-Athletic-Prize-Fight-Claude-Matthews-Bill, but was selected for personal reasons to the author, or for his commanding position in the Senate, to present a measure, *presumably*, to create competition in the letting of contracts, and to insure the building of safe and permanent structures. I use the word "presumably" advisedly, as there were many bills similar to the Roby act, which act, the statesmen were led to believe, was prayerfully demanded by all the athletic clubs and Y. M. C. A's in the State. In that act, the searchlight of time demonstrated that it was only Dominick O'Mally. Likewise, if the bill in question had become a law, time would have revealed a certain coterie of semi-leisurely gentlemen as the principal beneficiaries, and in my judgment at the expense of the tax payers.

The principal and only features of the bill were two: First, that any proposed bridge should have a definite and



complete plan on file for all to bid on alike. Second, that a competent "person" prepare and place said plan on file. Other features are not greatly different from the existing law.

Let us consider these two points. First, is it for the best interest of the public, who pay the bills, either for the present or future? Experience has taught us that in case complete detail drawings are on file, the party making the greatest error in estimating, or the party who willingly takes the work at cost or less, secures the contract. The former is the party who, of all others, should not have the work, for the reason that in nine cases in ten he is the incompetent party; and also that there should be a profit in the work for whoever does it. Again, it matters not how good a bond he may give, or how smooth a talker he may be, it is a foregone conclusion that the structure will not be perfect. For the second class, time, detail and workmanship will be spared to make up for the low bid that the "competent person" was forced to accept because of plans on file. The law says "the lowest responsible bidder," who may have facilities or may not, for the performance of the contract. Some one may say, "The fact of responsibility or bond given insures the work." It may insure the work, but not the character of it. How many of you would award the building of your private residences, after having complete plans made, to a stranger, although he proved his responsibility with a bond, without thorough investigation—not of responsibility, but of method, character of work and disposition to do the fair thing? Under the above law no question can be asked, other than responsibility and bond. Grant that a few bridges were built for cost or less, and this law would become general; what the result? It would be that the men who did honest work and paid competent engineers and workmen to do honest and perfect work, would be thrown out of business, on the same principle that financiers claim poor money drives good money out of circulation. Thus, when honest men have been driven out of the business by the unscrupulous bidder, who skins the detail and workman-

ship and omits the small things that go to make it perfect, you will immediately see an advance in the price of cheap jobs.

As to the second main feature of the measure : - Are we as a people, or a State, or a body of engineers, to stand still in the glory of present practice? I do not believe it can be successfully contradicted, that all the material progress in bridge building, as well as other branches of engineering, has been by the diligent, persistent and indomitable push and vim of the private person, or the company, in spending money, time and experiments to invent, contrive or design something to eclipse his competitor, and meet a reward by being suitably paid for it. To this end, bridge companies procure the best talent that money will buy, and this, together with years of actual experience in building, designing and overcoming difficulties, is brought to bear, and every minute of the year is devoted to the progression of their particular profession. Private gain is the end sought, not fame; and the gain is only in ratio to the progress. Fame is alluring in statesmanship or literature, but gain is the ultimate of the Polytechnic when the flat truth is told. Recognizing the old maxim, that "necessity is the mother of invention," the bridge engineer must keep abreast with the times and strive, not only to improve his own works, but see that a bright array of well-paid talent does not distance him. His goal is success; the incentive is great. How is it with the County Engineer? An average of two 90-foot spans per year; ten days work at \$5.00 per day. The pay never was nor will be sufficient to encourage him, even if the work was sufficient, which it is not.

Without reflecting any, whatever, upon the engineers of the State, it is only plain truth to say that there are only a few engineers in the State who are competent to follow the proposed law, by using the familiar designs, and fewer still who would be able to show any advance. The county engineers are not to blame for this, for the good reason that the amount of work does not justify the loss of time. For this

reason, under the proposed law, by a little judicious advertising the favored few could procure the work at their own prices. The general objection, as outlined against the principle of the county engineer making the designs, applies as well against any one person making the designs for a great State. The selection of a plan from a number of practicing engineers with their practical experiences, will furnish better plans, that will cost less money in a term of years, and at the same time keep up the advancement that competition makes a necessity. It may be said that there are no more reasons why a consulting engineer should not make plans for a superstructure than for stone abutments, a gravel road or a land survey. There are many reasons. Abutments are usually only a solid mass, and the engineer, knowing what they are to support, follows closely the plan of ages. The gravel road is a local matter, which demands local consideration exclusively, such as character of traffic, material that can be had, the wealth of the community (whether able to pay for first, second or third class roads). All this, it is true, demands keen and studied judgment. Land surveying is a science or profession that depends solely upon the knowledge of mathematics, and the skill of the engineer in his practice and working his instrument, as the system is as fixed as the everlasting hills. This is not the case with bridge engineering. It is true, all the local conditions must be carefully provided for; also, there is a length to go and a width to make; but there is no law in the universe that circumscribes the manner or method of so doing to the inventive genius, except the law of the lever and triangle.

Again, the men who make a success in life and invention, are men who devote a lifetime to a particular study. The men who have made the wonderful improvements on harvesting machines for harvesting grain, have been harvester manufacturers spurred on by the perfection of their competitors, and not the men who made hay rakes. The man who makes the hay rake may properly judge the workmanship and results of the harvester, but not in a thousand years

would he have tied the mechanical knot. Thus would I compare the consulting engineer to the special in any line. Then who will say to take the designing of bridges from parties who are devoting their whole time and energy to improve the science, and place it exclusively in the hands of the engineer three-fourths of whose time is put in on other lines, and probably has only one, two or three bridges to build in a year. We constantly hear from professionals the sin of allowing such structures to be built, as are being built at the present time. To a certain extent I wish to protest. I am fully aware that the bridges are not all what they ought be, but the bridge companies have to stand the blame for every 30-foot, 6-inch, worm-eaten hickory pole bridge disaster that finds its way into the public newspaper, while in ninety-nine cases in a hundred not even a bridge agent, let alone an engineer, ever saw the bridge. Now, the other side along this line. Prof. J. A. L. Waddell, an "advertised" bridge engineer, has seen fit to widely advertise, among others probably of like character, a certain bridge disaster that happened in the city of Lafayette some twenty years ago, when a new bridge fell with a few cattle, and has pointed it out as a shining example of allowing bridge manufacturers to roam at large. The facts are, that the plans, specifications, details of the whole monstrosity was made by the County Engineer, who had been the Chief Engineer of 300 miles of railroad, and who was ambitious to become the engineer in fact, as well as in name, of a great county.

Again, an accident in this state happened in which an 8x12 rotten oak floor beam broke under load, and caused the death of a citizen. A specialist in surveying, wired it to the *Engineering News*, and held up his hands in holy horror. The general readers would have taken him for a great engineer when those who personally knew the specialist, claimed that all the knowledge he had, was derived from serving as roadman for an engineer three months, and knew nothing about engineering in any of its branches. Another specialist in bridge work (out of the state however), thoroughly adver-



tised this state, seeking appointment as bridge engineer, and out of the ninety-two counties, found one county for which he made full plans. He was very particular to test every little batch of concrete filling that went into the set of cylinder columns, for its tensile and compressive strength, technical points were observed to the letter, but would you think it, the much despised bridge agent, detected error upon error in the main design. In view of the preceeding, I submit, which is the worse, selfishness, which is the only charge against bridge companies, or a blunderbuss. I do not say that all or any great number are incompetent; neither will others claim that all bridges are bad, or all manufacturers dishonest. When you come to strictly analyze the accidents, you will find they are caused mainly from the following reasons:

First—And by far the most, they are small culverts on short spans that are neglectingly allowed to rot.

Second—They are spans that have been built, by the practical bridge builder, who knew nothing about designing, except from *experience*, and could hardly tell whether a member was in compression or tension. For this state, these gentry have had their day, and are very seldom seen, except the railroads still keep them for bridge superintendents or inspectors.

The last of all, but the class that are laid up in the archives against the present age, are the old arch bridges, which were the first generally built in this country, and while in principle perfect, yet from poor details and weak floor system, have caused a number of disasters; these are serving a good purpose now, that of showing the progress of design, the result of competition. Their manufacturers deserve the thanks of the country fully as much as Cyrus McCormick for the invention of the reaper. Both were public benefactors.

I object to any system for building bridges, which are exclusively for public use, that does not permit of a free, and full competition for design and workmanship, and unhesitatingly state, in my humble opinion that the public will be better protected, receive more lasting benefit, and in a term

of years cost less money, than by a cut-throat competition on a single plan. There are those who believe, honestly, that there is too much fraud perpetrated in the present system. Let me say to such that no law prevents crime, but punishes it; on the same principle, no law, however framed, can prevent fraud. There is only one sure prevention known, and that is to elect honest men to positions of trust. Fortunately, fraud is much less than the public actually believes, and unfortunately, many men of integrity are unjustly suspected. The reform I concede to be necessary in this state, and the west generally, can be accomplished, so as to insure safe structures, well built, and not confine the great interest which is of vast public importance to the whim, prejudice, or corrupt action of any one man or set of men.

My plan would be as follows: Let the governor of the state appoint a competent person as State Bridge Engineer; one not less than thirty years old, who has been a practical designing engineer for not less than five years. Who is at the time of appointment a member of some state or national engineering society, and who must have the certificate of the President and Secretary of the society to which he belongs that he is competent to fill the position; who shall be appointed for a term of six years, and not eligible to reappointment to any term of more than six years in any twelve; his salary to be \$3,500 or more per annum and necessary traveling expenses; he to be allowed one assistant, to be selected by himself, with a salary of \$1,800 or more per annum and necessary traveling expenses; and to be furnished with suitable rooms in the State House at the capital; his duties shall be to furnish to the Boards of County Commissioners instructions as to rolling or live loads that shall be provided for on all bridges built within the State, whose chord is over twenty-five feet; and furnish an abstract of specifications as to material that will be required for the bridges of the State, making changes in said specifications or supplementing them when in his judgment it is necessary. At the March term of Commissioners' Court of each county they shall appoint a County Engineer, who may or may not

be County Surveyor, to serve one year, or until his successor is elected and qualified. Upon receiving notice from Trustees, as now required by law, that a bridge is necessary, the County Engineer shall, by order of the Board of Commissioners, proceed to make a survey of the location and report to the Board the number of spans, roadways, etc., required for said bridge, when they shall proceed to let the work as now required by law, but keeping within the rules and complying with the instructions of the State Bridge Engineer. When any superstructure or substructure is contracted as above, a copy of the specifications, plans and drawings shall be forwarded to the State Engineer, who shall place them on file in his office and who shall duly examine them, and if found to comply with the standard he has fixed, to approve them; if they do not, to notify the County Engineer that they do not fill the requirements and in what particular. The County Engineer shall notify the contractor, and if he fail to make the necessary changes within ten days to meet the views of the State Engineer, the contract shall be declared forfeited at the expense of the bidder and bondsmen, and the County Engineer and Board may proceed to re-let the work. No contract for bridge structures shall be in full force, virtue and effect until officially approved by the State Engineer in person or by regular deputy. Before work is performed by any contractor on a superstructure, he shall furnish a copy of the working drawings to the State Bridge Engineer, to be placed on file in his office, and must be approved by him before work is commenced in the shops. The contractor shall, at his own expense, furnish to the State Bridge Engineer reports of the physical and chemical tests of all the materials that enter into the structure. Such reports shall either be furnished by some well-known and established testing laboratory, or else be properly sworn to by the party making them. Any bridge substructure or superstructure, the cost of which is not in excess of \$2,000, shall be examined, when completed, by the County Engineer, and his certificate that it is properly completed according to plans, specifications and drawings on file in his and

the State Engineer's office, properly sworn to by the County Engineer, shall be forwarded to the State Engineer, who, if he is satisfied that the contract has been complied with, shall approve it; which certificate must be presented to the Board of Commissioners before they shall allow any part of the bill. Any structure the cost of which exceeds \$2,000, estimates may be allowed upon certificate of the County Engineer, with the approval of the State Engineer, not to exceed eighty per cent. of the actual work performed, as estimated by the County Engineer. But no superstructure the cost of which exceeds \$2,000 shall be paid for nor certificate given for final payment, until the State Engineer has visited the structure in person or by regular deputy and so reports. To guard against fraud and to preserve uniformity in costs, the State Engineer may disapprove any contract sent him, if in his judgment, after carefully estimating and taking into consideration all the conditions and local peculiarities, he be satisfied that the price named in the contract is excessive and unreasonable.

In my opinion, a law framed after the outline here given would, in the lapse of years, prove a very satisfactory one, both to the counties and to contractors. To the State, it would furnish bridges uniform in strength, character and material. To the county, it would not only do this, but save many a lawsuit and insure structures far in advance of most that are now built. To the contractor, the one-man power would be absent, but strict supervision over the contractor's work can only be invited, when he intends to be honest. This plan may be objected to by some on account of expense. I can only say, when we consider that there is \$550,000 expended in the State every year for superstructures alone, and the great portion of it with no supervision whatever, I submit that one per cent. used in this manner would be well expended. Others may object on account of "red tape," using a familiar expression. There must be checks placed at each point of advance in this matter, if desirable results are obtained. Whatever the outcome under such a law, I am sure there would be no more twisted-wire, gas-pipe or braced-arch (with mud for braces) bridges built in this State.



## RECENT ROAD LEGISLATION.

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BY J. F. O'BRIEN.

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To write an article on Recent Road Legislation is a task that has been allotted to me, and to produce anything new on the subject seems to be without the pale of probability. Since the earliest dawn of civilization, men began to settle in certain localities and build for themselves permanent homes, either in cities, towns, villages, or the broad expanse of the tangled forest or boundless prairies; contemporary with their permanent location, means of communication became absolutely necessary. This led men to devise some easy method of coming together. The copious rains from heaven wet the surface of "old mother earth" and the busy feet of trade mixed the elements into a sticky paste, which paste, by the intervention of "Old Auriborialis," in some latitudes, became so rigid and rough as to greatly impede easy and pleasant communication. Then and there the Solvus and Lycurguses of all lands began to try their hand at highway jurisprudence. Xerxes, the great Persian monarch, tried his hand at road legislation, and when he determined to chastise Athens for the assistance she gave his revolted subjects in Asia Minor, he ordered that a broad, well ballasted highway should be built for the easy and speedy transportation of his colossal army of 5,000,000 of men, and immense wagon train. The road was built almost as fast as the army could march, and upon reaching the Hellespont, he ordered a pontoon bridge of boats built across it, and his engineer at once set to work and made the bridge, but a tempest destroyed the structure and the engineers were beheaded for incompetency. Other engineers were ordered to make another bridge, and profiting by the example of their decapitated brethren, they built a bridge that withstood the ravages of tempest and tornado and safely carried the army over.

It would, indeed, be vain to attempt to enumerate all the progress made by people who occupied this globe, and of which we read in ancient and modern history, on the subject of road legislation and road building, but suffice it to say that the subject has always engaged a large share of attention of law makers of all lands. The improved state of the highways, in many European countries, has advanced manufacturing and agricultural industries to a very high degree of perfection by increasing the means and facilities for rapid and convenient public conveyance and communication.

We will now direct our attention to more recent road legislation in our native land. The first elaborate attempt at enacting any extensive legislation for the improvement of public highways was approved and became in force March 3, 1877. Now to discuss the statutory provisions of this law seems to be out of place here, since all the members are doubtless familiar with its workings, but we will briefly consider its fundamental principles. It is based on the doctrine taught by Henry George, that the lands alone shall bear the burden of tax for its construction. The drafter of the law was evidently a devout disciple of Blackstone, and his pen was evidently guided by the aphorism the "dancer should pay the fiddler," and that only those who had land would derive any personal benefit, and that landless teamsters anywhere, either within or without the prescribed limits, would not have the audacity to get upon the improved part of the road and help to wear it out, and that personal property was too precious to be touched for taxes. The said devout disciple of Blackstone certainly had an eye to business when he drafted the bill, for in it he made ample provision for appeals from one court to another, and in each appeal the devout disciple had, no doubt, visions of nice, fat fees for himself and his brethren. The grievous expense of law proceedings has long been a theme of complaint among the people, and those best acquainted with the law are best able to say that none of the complaints are ever exaggerated. The poor man can not get justice often in the matter of assessment of benefits or damages without paying more for it than it is worth.

The act concerning gravel and macadamized roads, approved April 8, 1885, is but little better than the law of 1877; in fact, it seems to be plagiarized from it. It is based on the same doctrine of taxing the land alone, and a long list of causes for remonstrance and litigation is worked in, thus affording excellent opportunities for Mr. Legal Long-tongue to get a case and earn a few honest (?) dollars and furnish Mr. Mudsill Farmer with further facilities for getting rid of any surplus cash he may have on hand.

Another bad feature of the laws above referred to is, that under their mysterious operations, additional assessments could be run on the lands whenever the contractor and commissioners thought it best for the best interest of the farmers (?) (or possibly for themselves).

Men being capable of continued and unlimited development, and legislators being no exception to the rule, have evolved, recently, a new law upon the subject of improving the roads. This law comes nearer the mark than any law yet enacted with which the writer is familiar. Reference is made to an act concerning free gravel roads, approved March 3, 1893. This law is based on the principle that *all* property in the township should be taxed for the improvement of the roads in the township, and that instead of a specific tax, as required by the old laws, the *advalorem* system should be employed and let the blessings of taxation, like the rains from heaven, fall alike on all. The law has a number of good features together with some bad ones. The good ones are, the taxing power is in the hands of the people. The question, to be taxed or not to be taxed, is decided by the sovereigns of the land under the quiet and secrecy of the kangaroo voting system; and that the voter casts his ballot knowing that the road he votes for will not cost more than the amount named in the report of the viewers, and that all the persons in his township will share the blessings of taxation equally—every man according to his assessed value—and that trusts, combines and corporate property of every description will help pay the tax; and

that all the proceedings are made public so that "he who runs may read," and every man may resolve himself into an expert road judge. This will prevent fraud and encourage road building. Some men grumble about taxes; they do this because of their shortsightedness, their selfishness and stupidity. The writer wishes to be distinctly understood to say, that taxes are one of the greatest blessings ever invented by civilized men; this statement needs only to be qualified by saying that money derived from taxes shall be expended in a judicious way, so that it will bring value received.

The writer believes that the proper administration of the acts of 1893 will result in much good and bring about a new era of road improvement. There are, however, some objections to the law that make it inoperative in some localities. The writer got a call to go to an adjoining county last summer to make a survey for a road under acts of March 3, 1893, and upon examination of the ground, found that nature had established the line for the road so near a township line that the township which would be taxed for the construction of the road would not derive as much benefit from the road as the one that could not be taxed at all. This unfortunate feature killed the plan for improvement and rendered the law useless, and thus twelve miles of rock road was not built. Because of township and county lines, many a weary farmer has to trudge through the mud this winter. The interest of the community, together with the natural topography of the county, should form the road district, regardless of township or county lines.

An amendment should be made to the law giving power to committee of three good men to decide in cases where township and county lines interfere with the proper working of the law, how much of the property of the adjoining township or county should be subjected to taxation for constructing the road. The law should also be amended so that poll tax could be collected for road purposes. The writer firmly believes that the repair of the road by the system of Road



Supervisors is a grand failure, and that the time spent by the road hands is worse than wasted. As a general thing, the salary paid to the Road Supervisors in each township would buy more good work, if judiciously managed, in one year, than is obtained from three years piddling under the present system. But there is one great obstacle in the way of abolishing the Road Supervisor's office, and that is the political cowardice of our legislators. They are afraid that they would loose some votes when they wished to be returned to the legislature. They know that among a certain class of voters there is a strong prejudice against paying tax in cash.

There are 3,508 men in our county who are subject to the order of the Road Supervisor and each man is liable to do about \$4.00 worth of work (or more properly neighborhood gossip) on the road each year which would amount to \$14,032.00, but the assertion is ventured that the most ardent supporter of the supervisor system will not hesitate to admit that \$5,000 in cash would put the roads of our county in better condition.

In concluding this part of the subject it is suggested that our legislative committee recommend the abolition of the office of road supervisor, and give the township trustees authority to employ a competent person to superintend the expenditure of all funds collected for the betterment of the roads of their townships.

The writer is happy to note that the question of improving our public highways is being agitated throughout the length and breadth of our land, but owing to our peculiar system of government, no laudable and commendable enterprise can meet with any marked degree of success until it shall first acquire the popular approval of the uncrowned sovereigns of the realm. It is indeed very gratifying to remark the rapid strides that are being made towards the goal of success. The missionary work done by a few pioneer agitators "will bring forth fruit an hundred fold," and a strong gale of popular sentiment in favor of good roads will sweep over our land like a mighty sirocco blast.

And bear before it with irresistible force,  
 The mud-loving pickers, with voices all hoarse,  
 No matter how loudly or fiercely they rage,  
 The croakers must go, not suiting this age,  
 To Zululand, or to the Hottentots go,  
 Or to the Esquimaux land and to slide on the snow,  
 Or to the Arapahoe Indians, on the prairies so wide,  
 And o'er the bleak deserts, on broncos to ride.  
 There no visions will trouble the croaker's sweet dreams,  
 No taxes for roads, nor for bridging the streams,  
 No torture from taxes, no troubles nor cares,  
 But chasing the buffalo, and the badgers and bears,  
 With joys without end, to forever endure;  
 There for sweet pleasure, from taxes secure.  
 For the progress of man, will quickly decide  
 That grumblers and kickers, must hasten to hide,  
 That the march of improvement will surely decree,  
 That the home of the croaker should be in the sea.

Now a few words in regard to good roads and this paper will close; the vital question of this age is good roads.

Bad roads are the devil's delight, why? Because bad roads are one of the most prolific causes of profanity. To hear the farmer swear at the road is satan's delight, all his imps shout, amen! "Go it, old man, you are one oath nearer home." They doubtless keep close watch on the old fellow as he bumps over the frozen earth or sticks in the mud and then begins to belabor his poor old worn out horses with a rawhide whip, and makes the air smell sulphureous with volley after volley of the most satanic oaths that his tongue can pronounce, and when the old man dies there is joy in hades, satan and his imps praise the bad roads.

If God and his angels observe the old farmer at all, they must certainly weep, for what pleases God distresses satan, and *vice versa*.

Bad roads lead to poverty and good roads lead to wealth,  
 Bad roads lead to misery and good roads lead to happiness,  
 Bad roads lead to wickedness and good roads lead to righteousness,  
 Bad roads lead to hades and good roads lead to heaven.

Much of the future of our country depends upon the condition of our public highways. Good roads will bring about

free delivery of the mail in the country; free mail delivery will increase the intelligence of our people, the intelligence of our people will perpetuate our free institutions and add greatness and glory and grandeur to our republic.

#### DISCUSSION OF RECENT ROAD LEGISLATION.

Mr. Goss.—I wish to say also in regard to 1893 law. It is probably the best thing that has been done in road legislation, and it has some things that are not good about it. I was called on last spring to make a survey of a road in one of our townships. I organized my corps and we went to the place of beginning. Meantime they had appointed two viewers, and, as usual, the viewers were two disinterested farmers. They were on time and started in to work. We went to work and worked part of the day and that afternoon we came to a hill. The viewers were ahead looking out the location and we came to a high hill, one that goes straight up and then when you get to the top, goes straight down again. I stopped when I got there, and the viewers were going ahead and we sent for them to come back and tell us where to go, and they said no, you will have to go up the hill. I asked why? Well, there was a politician lived right on top of the hill and he wanted the road to pass in front of his house, and he would have no way to get out without it. I run the line around the hill and it was less than one hundred feet further than over, but we went over because we had to; and after that the people along the line came to me and said, if you don't make the estimate on the road very low we can't carry it at the election; if I make it too high, something else will happen, and so it goes. The history of the road spoken of is, as far as I know, the general history.

O'Brien.—My experience has not been as bad as that. Clay County, just west of us, has just built twenty miles under the acts of 1893, and it is giving general satisfaction. A great many cities can be reached in Indiana by agitating this law, and the more this is done the more friends it has. The chief thing that I had to kill in the road I had to survey was this: The road could not be built without making a

new road; and the way the road now is, it runs along the north line of Lafayette Township. There were hills on the north side and a river on the south. I wish to say, that if that road could have been built on the north side it would have been built, but there was no way to take it that way.

Carmichael.—Does anyone knew anything about the Daily road paper presented last year.

Romack.—It seems to me that that law would not work very well in townships where roads had been built under the old law.

O'Brien.—To secure the making of roads in townships where there were no other roads was the intention.

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## SEPARATE SYSTEM OF SEWERS FOR SMALLER CITIES.

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BY CHARLES C. BROWN.

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I am afraid I will have to make a little apology for the rather fragmentary nature of my talk to-night, because I have not been able to write it out. When Mr. Fatout told me about it a few months ago, I told him I did not think I would have time to do it. I chose this subject because I have had to do a great deal of writing and talking on the subject for the last two or three years, and thought I could possibly talk easier on that subject.

The special point that we have usually tried to make in this connection is with reference to the cost of system of sewers. Most of our smaller towns and cities have not much money to spend, and it is pretty hard work to get that little money started. We have therefore tried to get the cost down to a minimum, so that they could possibly get it in. Now, I think it would be very easy to make an estimate for a small town, where we showed the vast difference there is in expense of putting in the two. I intended to work out an estimate of that sort for a small system, but as I said, have not had time to get that out, and will have to let it go until



some other time. I have written out just a little on the subject of cost, which I will read. I want to make one definition before I start. I want to make a difference between the sewer and drain sewer which is to carry off house sewage. I would like to restrict the sewer which is to carry off the surface water only and has no house sewage in it.

Prof. Brown then read a paper describing the separate as distinguished from the combined system of sewerage, the manuscript for which did not reach the printer, but the paper brought out the following discussion :

Bostwick.—I will ask where he divides his two systems.

Brown.—That depends upon the circumstances of the case. I think it is a good thing to have a certain amount of roof water going into the upper ends of the branches. Of course, you may want to save money, and if you do, it is a good thing to have a little water that comes from roofs; it is not as bad as street water. You cannot give any general rule for putting in roof water and leaving it out. You will find if you take it all in, your system is growing very rapidly, and while it does not grow as fast as if you take all street water in, you want to be careful. I have usually had the roof water left out and in a few cases where we could not get rid of roof water in other ways, let it go in. Every city ought to have a plumbing inspector and then you would not have any trouble.

Kinney.—Is it not a fact that the proper way to determine the size of a sewer is by section, that is, by means of your formulas and other means to determine the size of a sewer? Now, then, pipes are running into this sewer, and that will do for all practical purposes for one section, and any section is computed on up to the end.

Brown.—That is the way I tried to explain it.

Kinney.—That to have all parts of the sewer correct would be unnecessary, impossible and every thing else.

The President.—I would like to ask Mr. Brown, because I know he is not very old in his present office, whether he knows or any one else knows, whether we have any law by which a plumbing inspector could be appointed?

Brown.—I don't know that there is; it seems to me he ought to be connected with the City Engineer's office. I have not had time to present my ideas on this in Indianapolis yet. You can absolutely destroy the value of the sewer system by lack of proper connection. Now, ordinarily, the plumber knows less about plumbing than he does about anything else. About one plumber in a hundred actually knows what he is doing in plumbing the houses, and he surprises you a hundred times a day to see what particular devices he will invent. Now, a City Engineer is supposed to have charge of a city, and it seems to me as though it ought to be a part of the business of this office to see that the plumbing in the houses is properly put in and connection is proper, so it don't throw away all the advantage of your sewer system by the bad method of putting in the connections.

Wagner.—I know in the State of Ohio the sewers are regulated in this way, and the City Engineer is superintendent of that work, and I don't see why Indiana could not do the same. They get control of any other property they have and they should have power to regulate the piping of sewers and the connections therewith. The better plan is to have a plan of the pipe in the City Engineer's office, so any one coming in after him may examine any part of the sewer at any time. But I rather disagree with the gentleman in regard to separate system of sewers in small cities, because it is almost impossible to make sufficient street improvements without complete street drainage, and if we want that we must have this system of sewers. Now, to build a sewer to carry some water and to carry some sewage would be much more expensive. Our sewer pipes are not generally very costly, unless it runs to extreme size; and most of our small cities or towns can carry their sewage in sewer pipes even if they cannot, brick sewers can be constructed very reasonably.

President.—In planning a system of sewers it becomes almost impossible to carry the sewage entirely beyond the city limits, and what flow of water per second will it require assuming that the city has a thousand inhabitants.

Brown.—That is a subject I have been studying for four years and have not settled it yet and I think it will take a good many more years to get it settled. I think it is generally estimated that about 150 cubic feet a minute per thousand will be sufficient to dilute the sewage. That water should flow quite a number of miles in order to be used for any ordinary purpose afterwards. It seems to me in answer to one or two points mentioned that it is possible for our City Councils to pass an ordinance regarding plumbing inspection, and that is all that is necessary. It is entirely within their powers to produce the proper department to make the plumbing inspection. In regard to the two separate systems of sewers I have amplified upon that point as much as I would like, but I think there is no question but what there are cases where it is more economical to put the two together, but in our smaller cities there are usually but few of the streets which are what you call paved. The ordinary McAdam Street is the common street throughout the city. There are only a few streets in the business part of the city which are really paved with any ordinary kind of pavement which would require the erection of catch basins at every corner of the street. It seems to me, unless the city is perfectly flat, it is possible in nine cases out of ten, to take care of the street water with a very small number of drains.

Kinney.—I would like to know, Mr. Brown, if you can give any reason why that a small sewer, particularly a drainage sewer, I think of now and one used for sewerage line, should be placed in a paved street. Is there any reason why it should not be placed in alleys as well as streets. The fact of the matter is that the connection is ordinarily made in the back part of the house.

Brown.—I have been in New York for the last five or six years and we have no alleys there and we have to run them in the streets. The trouble in putting them in the alleys is that the plan of the city is not as regular as far as the alley is concerned and when you try to lay out a complete system you find it very difficult to lay a complete sewerage system in the alleys. They must go into streets.

## THE CONSTRUCTION OF SEWERS.

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BY C. L. KINNEY.

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I would like to say in opening in this regard that I am inclined to think that the title of this subject is not just what it should be. In fact I am like the fellow who took a subject and preached from it. The fact is that subject is a little different from what I got it but I will read what I have prepared and by the way I will say, so as not to stop when I begin reading that two thoughts came to me as I sat there, that all the good ideas I had about sewers, I left out of this paper and that had I not heard Mr. Brown's paper or I might have written something better.

Sanitary science is of a modern growth, and it is within the memory of some who are listening to this discussion that the subject has engaged the attention of scientific men. Yet it became apparent that as civilization tended to concentrate population the greatest enemy of man was himself. Sanitary science is simply an aid to nature in disposing of those compounds which are being eliminated from the animal system. In close relation to sanitary science is sanitary engineering. The scientific man has theorized the plan, and it now remains for the engineer to carry them out. The question now arises, how shall this be done? The answer in this paper shall be by means of sewers and drains, the first of which shall be discussed principally in this matter touching perhaps on the latter incidentally.

In laying out and preparing plans for sewer districts there are so many different conditions that it seems at first sight that no laid down points for consideration can be furnished; but here I wish to give the civil engineer credit of being able to meet with and overcome more obstacles than any other class of men.

I have therefore prepared the following which in my experience will cover the grounds generally:

First—The population within the district.



Second—The physical character and area of the district.

Third—The rain fall and the amount of storm water to be carried.

Fourth—The water supply.

Fifth—The disposal of the sewage.

After having thus outlined his course, the engineer is ready to begin work. Leaving the subject of population to poll books or other reasonably correct records, the engineer begins his active work by making careful survey of his proposed district, computing carefully the area, noting very accurately the physical condition of his district. Very much depends upon this. The district of course to be carefully mapped showing the streets, alleys and general physical conditions by means of contour lines, or such other means as the engineer may devise.

Having the general plan of the district, the next step will be to divide the area into sub-districts, the area of each sub-district to be noted, the value of which we will set out as we proceed. This part of his work being carefully done, he will now turn to the third proposition, that of rainfall and the disposal of storm water.

The engineer in the average Indiana town will, no doubt, find the expense of the double system of pipes too great for consideration; hence he decides upon and recommends to that august body, the Common Council, a double service system, that is a system of pipes so made and constructed to carry off surface or storm water as well as a house and barn sewage. The matter of rainfall now becomes an important factor, and it becomes necessary to acquaint himself with the average precipitation, as well as the maximum depth in inches per hour. From my own observation, and from reports at hand of the United States Signal Service, I find an average of but one storm out of one hundred and twenty-seven wherein more than one inch of rain falls in one hour, hence I concluded that if provisions were made to carry off one inch of rain falling in an hour, it would suffice; although greater storms might be anticipated, yet their

occurrence would be of such long intervals, that the expense would not warrant the building of a system adequate to such excessive storms. The engineer now comes to an important factor in the preparation of his plans, namely, the size of the sewer. No given size can be anticipated or recommended, in this paper, for any given area; circumstances and conditions differing in every locality.

The velocity of flow depending upon the length of the sewer, rate of inclination and size of the pipe. For example, using the hydraulic formula of pipes under pressure. A circular sewer of ten feet in diameter, having a fall of two feet per mile, would have a velocity of three feet per second. A sewer of five feet in diameter, with a fall of four feet per mile, would have a velocity of three feet per second. A sewer of one foot in diameter, with a fall of twenty feet per mile, would have a velocity of three feet per second. Now, multiplying this velocity by their respective sections, the ten foot sewer will discharge one hundred times as much, the five foot twenty-five times as much as the one foot sewer. Hence, in giving inclinations to sewers with a view to self-cleansing, regard must be had to the volume of sewage; but the question frequently confronts the engineer reversed; that is, a given rate of inclination only can be obtained, hence the size of pipe depends largely upon this. In general, however, the greater the fall the smaller the pipe need be. The house sewer and water supply will now be considered before final decision upon the size of pipe. From tables at hand, it appears that the house sewage may be averaged at about one hundred and twenty gallons per inhabitant annually. The water supply depending wholly upon the system in the district under consideration.

That I may be well understood in determining the size of sewers from the above, I have deduced the following upon which to base calculations:

First—Number of inhabitants in the district.

Second—The area of the district.

Third—The physical conditions of the district.

Fourth—The amount of rain fall.

Fifth—The rate of inclination.

Having now determined upon the size of the sewer, working plans should be prepared showing size of pipe, location of man-holes, Y's, T's, lantern holes and catch basins or inlets. (Right here let us recommend the Sibley & Ware catch basin or inlet, made at South Bend, Indiana, as being as good, if not the best, inlet made.) These plans, of course, should show of what material the sewer is to be built, whether of brick, stone, cement, wood or burned clay pipes made for such purposes; if brick, whether of one or more rings; (I have here suggested one ring in deference to our worthy Chairman, my friend Mr. Whitten,) if of cement, how thick and of what proportion; in short, giving in detail everything in connection with the proposed work. I wish here to urge upon my fellow engineers to stick closely to his plans and insist upon their execution.

The disposition of the sewerage is a subject that perhaps should have appeared earlier in this paper. The foregoing, however, has been written with the idea in mind that this had been decided upon. The subject has been a fruitful source of embarrassment in all localities. This field of discussion is too great to be opened in these pages, yet a few thoughts may not be out of place. As may be supposed, the prospect of pecuniary gain has brought many schemes before the public; on a small scale some have given promise of success, which a more extended trial has shown to be fallacious. These efforts have, no doubt, been kept alive from the well known chemical law that the waste of animal life forms the sustenance of vegetable life, which, in turn, remoulds the elements into new shapes for animal uses, carrying out nature's economical transformations. Other views have been regarded as wasteful and unscientific.

The chemical processes are very numerous:

First—The lime process.

Second—Scott's process of lime and clay.

Third—The filtration process.

Fourth—Weaver's process through charcoal and cinders.

Fifth—The dry earth process.

Not to mention cess-pools, pails, boxes, tubs, etc., all of which have been largely used. This question is most readily solved when the district to be sewered lies adjacent to the sea or inland streams, and yet, if the cities are large and the stream small the problem is still unsolved. In which condition we shall leave it for your further thought and consideration.

Specifications should be carefully written, setting out in full the manner of doing the work, with full instructions to the contractor; these should be printed and in the hands of every bidder, that no misunderstanding as to the requirements could be claimed. These need not be exhaustive, but should be clear and concise.

We are now ready to begin work, which if properly done under the careful direction of the inspector, in the great hereafter, if not on this earth, the much abused engineer will hear the joyful words, "Well done, thou good and faithful servant, enter thou into the joys above."

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## GOOD ROADS QUESTION.

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BY WILLIAM FORTUNE.

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I hope there is no expectation of anything like a great address from me. I received a letter from Mr. Carmichael that in making up the program for the evening, he had put me in and he hoped it would work out all right, but I have not anything to say. Nothing prepared whatever. Am very much employed recently in the care of the poor who are unemployed and I would like to have had opportunity to prepare something. The question is a practical one. I believe the class of people who are interested in the agitation of building of good roads, and I have no doubt you are sufficiently interested in the work when you can get it to do.



The good roads improvement, as you are well aware, during the last two or three years has made very remarkable progress in the country generally, and I am happy to say that it has taken very good effect in our own state. I very strongly had the feeling that if any effort to put Indiana to the front as one of the foremost states in civilization and all that is for the betterment of mankind, that we could not do a better thing than to take the lead in building a great system of common roads in the United States, and it has been often referred to as the best indication of highest civilization. We find it so in the world wherever there is advanced civilization. We find it so in a degree within certain boundaries. We go to those parts of Indiana that are recognized as being in the lead in a civilized way in all the higher thoughts and refinements of life and there you find the best roads. I speak of the subject in that general public way of the interest and benefit rather than from any interest or benefit on the part of road building which is the particular in which you gentlemen are interested. To those who take the time to look into it a little it is amazing what large figures it runs into, and to those who take the time to study it in its social effects, it is equally amazing to find that in the development of that thought which is best for fellow man, there seems to be a very close relation between this matter of good roads. It is a most deplorable fact that in the United States, a country that has been progressive beyond anything in the history of the world, we seem to have given less attention to this matter of our common highways than almost any one in the world. With every opportunity for upbuilding, it seems to be a matter of scarcely any thought to Congress, who wastes millions and millions of dollars upon something that brings no practical benefit. I don't want you to think that I would advocate national aid for road building. National aid for good road building, as it is called has some time been put forward as an advocate of that idea but I don't think that it is the opinion of those who have given most thought to the subject that it is the practical or advisable thing.

Building of our roads for practical reasons, both practical and governmental must be done by localities and by the city and wholly without national aid. It is a mistake of the government, I firmly believe, to carry out the idea of national road building. In Indiana we are annually wasting enough money to build a system of highways within ten years. The one thought that seems to stand out in the minds of the people generally is that if we should adopt a new method of spending this money that some of it might go to the men whose service should be employed in directing the work.

In the last road congress the idea was put forth that the road system should be inaugurated in this state under the direction of the civil engineers who were to make the roads. Unfortunately for the movement that called forth that anything done for the civil engineers was simply a scheme on their part to rob the poor farmer of that benefit. The great thing we have to contend with in this road congress is ignorance. I say that with a good deal of regret, but I believe it to be a solid truth. I believe that in any movement that we make regarding improvements of highways in Indiana, that we must recognize it and deal with it accordingly. I believe in going along the way I believe to be right and in a public way would not be a success, but I simply throw out that suggestion as the one thing that must be met in the further steps that are taken in the good roads question. I have the utmost regard of the value of the service of the civil engineer; I have every reason to have. Every man who takes the time to give a little thought to these matters, I believe cannot feel otherwise. I hope therefore I will not be misunderstood when I make the suggestion that assuming that you are all interested with every citizen in this movement for better roads that the time for the best service of the engineer is when we reach that point, that practical building of roads there in agitation, that their best service is held in hand and not put forward. I have a feeling at the time and have had ever since that it would have been far better for this good roads movement a year ago if they had not put

forward any plan or any purpose to the legislature. We cannot afford to let alone at this time the practical question of how we will get the money for these roads.

As Civil Engineers you have had experience, and you know there is no question upon which men are more intent than upon street improvements. Every man believes he knows just what kind of pavement should be put in and he knows it without having studied it very much. He has an idea that the street ought to be paved with brick. Experience or technical knowledge are nothing to him. Probably easily accounted for. Probably because they are good citizens. But, anyhow, that is the case. So it is with roads. Another man has an idea it should be done in another way and he begins to discuss the question. The idea that I want to get before you in the good roads improvement, is just simply a question of getting good roads. Let it be determined afterward how they shall be built, whether by engineer or surveyors. That will take care of itself if we can bring the people to a proper appreciation of having good roads. We have made very little progress in this State; it was wholly impossible to get any legislation. They did pass a bill that in a very small degree, did seem to me was a step in the right direction, and that is in taking the road supervisors out of the hands of voter and putting him under the township trustees. The road supervisor is now under the control of some one who is under the control of the council. We will take a step farther when we put some one in charge of him. He is only in a little better position than the road supervisor. He probably knows just as little.

I hope you will all be in attendance at the road congress.

## PUBLIC HIGHWAYS.

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BY 

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Endeavoring to comply with my part of the programme made out for this meeting, I respectfully ask your indulgence for a time while I call your attention to a few of the many points concerned in the construction and maintainence of our public thoroughfares; a question which just at present is uppermost in the public mind throughout our whole country, and I may with propriety here add, that it is certainly a most laudable question for discussion, subservient I take it, to none save perhaps that of sanitary drainage of cities and towns.

You will please pardon me should I startle you by announcing at the outset of this paper, that the public highways of this country are, as a rule, worse than in any other civilized country on the globe; nevertheless, expressions coming from numbers of our most learned and experienced men, both public and private, will, I trow, bear me out in the statement. Furthermore, should only half be true of the many disparagements uttered against our public highways, what a sad commentary on the intelligence, the spirit and enterprise of the citizens of our noble, free America, whose stars and stripes stalk shoulder to shoulder with the emblems of all the nations of the earth, with the proud mien of equality stamped on its front.

You may ask what connection roads can possibly have with the intelligence of a people? I answer, they are unmistakable evidences and certain tests of the degree of civilization to which that people have ascended, and their betterment, improvement and extension keep pace with the increase in population, intelligence, prosperity of the inhabitants; all of which is at the same time emblematic and evidential. We may by way of simile liken the common wealth or national union to a body politic, of which the



roads and throughfares are the veins and arteries constantly carrying the stream of life-giving products that sustain the entire structure of state; obliterate them, obstruct them, or interfere with their natural functions, and all the eurdition of a Mills or a McKinley would be wholly inadequate to create an available market for another bushel of corn, or another pound of pork.

But it seems that public highways belong to that class of blessings of which the value and importance are not fully felt, because of the very greatness of their advantages, which are so many and so indispensable as to render their extent almost universal, and their origin hidden in the debris of time, to which the memory of man runneth not to the contrary.

Referring back to the simile above mentioned, what more natural conclusion can we arrive at than the national union being the vital concomitant of the highway system of a country, should not engage and take upon itself the duty and responsibility of furnishing to all its people as correct and complete a system of avenues, of interstate and local intercourse, as is within its power.

I am inclined to answer that interrogatory affirmatively. And at this juncture I desire to advance my advocacy of a national public highway system. My reason for the same are, in the main, as follows: The great weight, dignity and universal respect given to all branches of public concern in which the management of the same is in the hands and under the control of the general government officials. Also for the reason that there will be no doubt of the work having been done when once laid out and directed to be done, and if under the supervision of competent men, which would be more than likely, the work will be well and satisfactorily done.

We find so many and satisfactory proofs of the good results of a national system of highways in countries like France and England, and many other European countries, and the favorable expression from men whose observation

and experience lead them to take that view of the question. Among the latter I will call your attention to the following names of persons who took an active part in the recent call for a national good roads convention, which met in Chicago, October 20, 1892: Gov. Fuller, of Vermont; Judge Thayer, of Iowa; Gen. Roy Stone, of New York; William Fortune and Clem Studebaker, of Indiana; Col. Albert A. Pope, of Boston. The latter of whom is circulating a petition among the college presidents, railroad presidents, postmasters and others, with the request that they sign it and aid in getting others to sign it. The gist of said petition is, that congress cause to be established in the District of Columbia, a Road Department, similar to the Agriculture Department, for the purpose of promoting a knowledge of road-making and for teaching students, that they may become skilled road engineers. And we also have the hearty co-operation of the Hon. Ex-Governor Ira J. Chase in the following words: "I shall favor any plan or means for the betterment of our public highways, as I am sure our state will be benefitted and the welfare of our people augmented." We have the following endorsement from Hon. Clem Studebaker, of our own state. He says, "To my mind, the government, state and national, might, with entire propriety, give material aid in the building of public highways; this was the doctrine of Henry Clay, and it is as good doctrine to-day as it was in his time. Government dollars might often be much better spent in the improvement of roads than in deepening harbors, or making creeks as navigable as rivers."

I am in accord with the foregoing sentiments and believe they could be made practicable, and the county, state and local authorities could work to advantage under a national reigme. Let the national organization devise a system of highways adapted to the physical conditions of the several states, and let each sub-division be presided over by a competent civil engineer, who is capable of determining the physical contour of his district, and be able to prepare the

proper plans, profiles and specifications for the work required to be done in his locality, and take the proper steps to have the same done in all respects as intended.

Now at this juncture allow me to state that our roads for the greater part are most dangerous and unsightly. Dangerous because of the fact that it is the habit to build up and grade the road-way to quite a height, often eight or ten feet of an embankment, and so narrow on the top as to scarcely allow of the passage of two vehicles; and who of us have not now unpleasant recollections of some incident during our travels wherein we were at the verge of being precipitated down an embankment, and imperiling our life or limbs. And doubtless many of us know of one or more damage suits brought against the county or township to recover damages caused by such gross imperfections as mentioned above, saying nothing about the many dangerous and disagreeable bridges, culverts and small stream crossings met with on all our thoroughfares.

I hold that such precautions should be taken with reference to constructing as to have them absolutely safe, and free from any possibility of hurt or injury occurring to any one having occasion to ride, drive or walk over the same. We are all cognizant of the fact that our breed of horses is rapidly improving, a most commendable condition of things, and with it an animal full of life and spirit, quick and agile as a cat, capable of springing its full length in a moment at sight of some object suddenly coming into view, and unless there be sufficient surface upon which to control him, dire results must surely follow. Our public highways are, as a rule, unsightly, because of their sides being fringed by a growth of small trees, bushes, briars, racked and tumble-down fences, farming implements, old buggies, wagons and whatever else may be of no use on or about the farm or home, and I wish to add to the list the always present and ever smiling chasm, on either side, misnamed a ditch.

Rapidity, safety and economy of carriages are the great objects to be attained in roads, and I will proceed to state

to you what, in my judgment, roads ought to be; not what they shall be, but what they ought to be in order to obtain the best results in their use.

And as to what roads ought to be, I will endeavor to tell under the following heads:

First, as to their location, their construction and their improvement of surface.

What roads ought to be as to their location. They should be located in such a manner as to reach the point desired as quickly as possible, which, of course, would be a straight line, were the surface over which the road is made is perfectly level, or nearly so, which in most parts of our state is not found for any considerable distance.

Dr. Lardner, in 1836, says: "I do not know that I could suggest any one problem to be proposed to an engineer which would require a greater exertion of scientific skill and practical knowledge than laying a road."

I will mention the following requirements in laying out roads:

First.—That the road ought to be as nearly in a straight line as possible, but straightness ought to be made subordinate to easiness of grade.

Second.—That the grade ought to be as nearly level as possible; that it should avoid unnecessary undulations, and that its slope ought to be not greater than one in thirty, nor fall below one in one hundred and twenty-five.

Third.—That the cost of construction, the amount of excavation and embankment and mechanical structures, etc., should be the least which will make the road "what it ought to be," with reference to the quantity of traffic upon it.

Were the country through which the road passes a plain of uniform surface, a straight line joining the two termini and running the surface of the ground would satisfy all these conditions at once. In most cases, however, the ground is so uneven, hilly and undulating, as to prevent very great difficulties in the way of a proper location; the shortest line would pass over the tops of hills and the bottoms of



valleys, and would thus be often so steep as to be impassable. The most level line would often increase the distance too much by its necessary windings; as would also the cheapest line, which seeks to avoid all cuttings and fillings. Great skill is therefore required to select the best possible line among these conflicting claims, and thus skill is more needed in our new and rapidly developing country than in the older countries of Europe, where the highways have long been established, and one would judge permanently fixed; but we are instructed that many changes are constantly being made even in those countries.

A good general route can in many cases be satisfactorily determined without going over the country, by reference to a map of the country showing the course of the streams, from them a skillful eye can determine with fair accuracy all the main elevations and depressions, providing one has a fair knowledge of physical geography, for we are taught by that science, that nature has not formed the hills, valleys, and undulations of surface without system, on the contrary they are arranged and depend on well defined natural laws, governing all their seemingly unconnected natural conditions and formations.

After taking due cognizance of the foregoing conditions it becomes necessary to select the route desired, which will be done by proper surveys, a good map of the contiguous territory should be prepared, and at least to routes surveyed and levelled then by a comparison of the map and each survey it will not be a difficult matter to determine the route most desirable. After having selected the final location it will then be required to rectify the line surveyed, by introducing the proper curves, main bends, zigzag portions of the line straightened, and such other changes as the nature of things will suggest.

Having duly considered the foregoing requirements, the next thing will be the construction of the road, which should be by contract let to the lowest and best bidder, all things taken into consideration. A specification should be prepared

containing an exact and minute description of the manner of executing the work in all its details, copies of it with maps, profiles, and drawings are to be submitted to the inspection of the persons desiring to undertake the work, and who ought to be invited by advertisement to hand in sealed bids to the proper person, based upon the price per cubic yard or foot, or whatever conditions the engineer may desire to let the work.

Upon disposing of the construction as above, and when the line is completed the next problem that confronts us is the improvement of its surface, which I will discuss as follows: The surface of a newly made road is generally very deficient in the important qualities of hardness and smoothness; and to secure which, in their highest degree, it is quite necessary to even the earth which forms the natural surface of the road with stone, wood, gravel or other unyielding substance. The object of this covering is two-fold.

First.—In substituting a hard and smooth surface for the soft and uneven earth.

Second.—In protecting the ground beneath it from the action of rain-water, which by penetrating to it and remaining upon it would not only impede the progress of vehicles, but render the road too weak to bear their weight.

Such a covering as mentioned above should be the purpose of affording an arch or roof of whatever material may be used not to act as bridges alone to bear the weight of vehicles, but to protect the natural surface beneath from the action of the weather. It should not be considered as a substitute for the soil under it, but only as a protection to it, in order that it may preserve its natural strength. Erroneous views no doubt have been the cause of very prejudicial practices and opinions on the question of road building. In discussing the improvement of surface of roads we will examine the question under the following heads: Earth Roads, Gravel Roads, Broken Stone Roads (Macadam), Paved Roads, Roads of Wood, Roads of other Material, Roads with Trackways;

First.—Earth roads are very deficient at all times, unless their surfaces be improved by art; they are wanting in the required smoothness and hardness, and in the spring are almost impassable; but however faulty they may be this kind of a road is all that we can hope for, in most parts of this country under the present conditions; and every effort should be expended to make them as near what a road ought to be as possible. The faults of surface being so manifest and so great, we should endeavor to lessen all other defects as much as possible, and endeavor to make the grades conform to a standard of 1 to 30, if possible, by winding around hills, or by cutting them down, and filling up the valleys. The surface should be shaped and properly formed with a slope of 1 to 20, each way from the center. The drainage should be made very thorough, indeed I hold that much depends on the drainage of a road bed under all and any conditions. Drainage alone will, in many cases, change a bad road into a good one, in fact no permanent improvement can be made without effective drainage. Trees should not be allowed to grow along the side, thereby intercepting the rays of sun and wind from the surface of the road. If the soil of the road-bed be loose sand, its surface can be materially improved by mixing clay with it, making a covering of about six inches of clay, and of sufficient width. If the road-bed be of adhesive clay, then an application of sand in a similar manner will produce good results. When the road-bed becomes worn in places, what is called chuck-holes are formed, and the pernicious habit of filling them with muck, brush, straw, sod, turf, etc., should be condemned, as also filling them with large boulders; nothing but the best material should be used, and it would contain as large a percentage of gravel as possible. I would here introduce the broad tire wheels idea, and advise that sort of heavy vehicle for all farm work, and heavy hauling on dirt roads. The narrow tire wheel is very damaging to the surface, as well as imposing additional labor on teams. I understand that the New York turnpike law only requires a toll charge of one-

half as much on wheels whose tire is six inches, as on narrower tired wheels, those of nine inches, one-fourth; and those of twelve inches, no toll at all.

Second.—Gravel roads have attracted the most attention in our state for general highway purposes, and if properly constructed are far superior to roads of common earth. Care should be used in the selection of gravel that it may not be too much washed, if from the shores or rivers, as it may not contain enough earthy matter to pack well and quickly; also the other extreme should be guarded against if taken from pits, that too much earthy matter be not allowed to remain among the gravel. The road-bed should be well shaped and drained, the gravel should then be put on in three layers of four inches each, and each layer well rolled and packed before another is made; wet weather is the best time for packing. An erroneous habit is followed in many places of putting the larger boulders at the bottom, which in time become loosened and worked to the surface, the smaller ones descending like the material in a vibrating sieve, and the road will never become firm and smooth.

Third.—Broken Stone Roads. Under this head are two well defined systems in use—that called Macadam and that called Telford. The latter is based on the theory of an under layer of pavement, while the former denies the necessity of any foundation beneath the broken stone covering. Macadam roads have obtained in the west on account of their cheapness, while the Telford system obtains in the east and older countries. In either case these roads are far too expensive to become of general use, besides, the surface presents, in the summer time, a disagreeable feature, that of an annoying dust; and in rainy weather, a disagreeable mud or slush.

Fourth.—Paved Roads. A good pavement should offer little resistance to wheels, but give a firm foot-hold to horses; it should be so durable as to seldom require taking up; it should be as free as possible from noise and dust, and when it is laid in the streets of a city, it should be susceptible of



easy removal and replacement to give access to gas and water pipes. A common but very inferior pavement is that of the cobble stone variety, which ought to be universally voted down. All pavements require a good and suitable foundation upon which to rest, which may be of broken stone, pebbles or concrete, and in this case, attention to thorough drainage should be observed.

Roads of other material, such as burned clay and charcoal, have been used with a fair degree of success. Of the two last mentioned, I would be more in favor of burned clay, as experience with it has proven that a very good substitute for brick can thus be obtained with a small part of the cost of brick.

There have been attempts made to improve the surface of roads by means of the use of wooden track-ways, and of stone, either of which I consider impracticable for any great length of haul or considerable traffic.

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## REMINISCENCE OF EARLY WORK OF RAILWAYS.

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BY JOHN CASELEY, KNIGHTSTOWN.

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Mr. Morrison.—Mr. Caseley is now an old gentleman of about eight years, and has been a prominent manufacturer at Knightstown for a long time, and this paper was presented for publication at our last meeting, but on account of Mr. Caseley not being a member of this Society, and on account of other things, it was crowded out, and I am now permitted to read the paper and we expect to have it published in the coming report. I would like to remark about this paper that it is a little late, coming after the Chicago Exposition, where the same kind of tracks described here were to be seen. It would have been much more to the point to have been read before the tracks were put on the Chicago Exposition ground, but everything that was shown there shows that Mr. Caseley is precisely right in the statement about the construction of the rails.

## THE FIRST FISH-PLATE.

[Patented in England in 1849.]

I commenced working on the Leeds & Selby Railway in the County of York, England, in the month of April, 1832, and worked at excavating for more than a year. In the summer of 1833 I worked with the plate-layers (track-layers) as a block-steadier. Track-layers were called plate-layers, and plate-laying was considered a scientific business in those days. The track was laid on stone blocks, two feet long, two feet wide and one foot deep. Each block weighed five hundred pounds. The blocks were laid under each, three feet apart from center to center, without any sleepers or ties. To make it more plain, I will give a description of the blocks and the method of setting them. The cast-iron chair had two spike holes in it. The first thing to be done with the block was to take the chair and place it as nearly on the center of the block as practicable, and mark the places for the holes to be drilled in the block, and then to drill the holes six inches deep. A turned wood plug was driven into each hole and then the chair was properly bedded on the block and spiked with five-inch round-headed spikes driven into the wooden plugs. The chair, thus fastened to the block, would bear the weight of the block without drawing the chair.

It required two men to set a block—the block-setter and the block-steadier. We had a strong tripod, five feet high, and a twenty-four-foot lever or pole. The big end of the lever had a band and hook of iron. Three feet from the hook was a strip of iron two inches wide and a quarter inch thick, with six holes that fitted on an iron pivot on top of the tripod, so that the lever could be moved backward or forward, as required. There was a chain with a temporary fastening to the chair on the block and to the hook on the lever. The block-setter at the small end of the lever could easily swing the block.

The line and level stakes were put in by the engineer at short distances. The block-setter, at small end of the lever,

would see that the tripod and block were in line; the block-steadier would lay his hands on the block, and the man with the lever would raise the block six or eight inches, and let it fall five or six times, or as many times as would settle the block in line and level. A joint block-setter would set from fifteen to twenty joint blocks per day, and put the rails in and line them. This was for only one line of rails. The middle block-setter would follow, turn the rails out and set the blocks between the joint blocks. Thirty-five middle blocks was a day's work at that time, but a few years latter, we could set more than double that number of blocks per day.

The rails on the Leeds & Selby Railway were only twelve and fifteen feet long—more twelve than fifteen feet. They were single faced and weighed forty-five pounds to the yard. They were keyed on the outside with an iron key.

The projectors of this railway had an idea that a double track would be capable of carrying the traffic between the terminal points (only twenty-miles), so they built several under and over bridges for four tracks. Early in 1834 a locomotive engine was brought out from Selby to haul ballast (broken stone). This engine had four wooden wheels with heavy iron tires with flange. The wheels were coupled outside. Two barrels of water stood in front of the engine to supply it with water. The weight of the engine was about six tons, and it would haul eight or ten cars, with two yards of ballast in each car, at a rather slow pace. It was often out of fix and had to go into the shop for repairs so often that the engine got the name of "Simon Hamer's Folly." Simon Hamer was one of the contractors.

This road was opened for traffic and passengers in September, 1834. The four locomotive engines that operated it were four-wheeled. They were coupled outside and weighed about seven tons each.

We commenced laying track from the Leeds & Selby Railway to the City of York, sixteen miles, in the fall of 1838. This is now a part of the Great Northern Railway. Wood sleepers (or ties) were used except for a short distance

at the York end where stone blocks were laid. The rails were single-faced and were twelve and fifteen feet, some few eighteen feet long, being the first eighteen feet rails I had seen. They had what was termed the R flap joints. The ends were heated in a blacksmith's fire and a piece of the top of the rail was cut out and the web of the rail end was bent so that the top of the rails lapped sideways against each other for about three inches. The cast-iron chairs had holes for plug and feather and were keyed inside, the joint-chair was keyed both inside and outside. The rails were sixty pounds to the yard and made a very good road. The engines on this road were twelve to fourteen tons in weight. This railway was opened for traffic, from the Leeds & Selby Junction to the City of York, on the 29th day of May, 1839, which was the last time I saw George Stephenson, the father of railways.

After this, I was track laying on the London & Southampton Railway. This track was laid mostly on wood sleepers (ties), some few miles being on stone blocks. The rails were double-faced, seventy-five pounds to the yard, and had jump joints with wood keys outside. The renowned Thomas Brassey was the contractor. It was opened through from London to Southampton on the 11th day of May, 1840; from London to Basingstoke, forty-five miles, had been opened in 1839. After this, I laid track on the Eastern Counties Railway, from Romford to Brentwood, in the county of Essex. The rails were all fifteen feet, double faced, seventy-five pounds to the yard, keyed outside, with wood sleepers (ties), which were placed five feet apart. On one part of this road there was twelve feet of cut, and to facilitate the work, they dug the foundation and put in an over bridge before the cut was made. This should have been a straight line, but the engineer who staked out the bridge made a mistake and put the bridge more than three feet out of line. This mistake was not found out until after we laid track, and we had to make a light S curve to get through the bridge at proper distance from the abutments. John Brathwaite was engineer-in-chief on this road.



After this, I was track laying on the London & Brighton Railway. We had double-faced rails, seventy-five pounds to the yard, jump joints, keyed outside with wood keys, mostly wood sleepers, but some stone blocks. Here were the last stone blocks I set.

After leaving this, I laid track on the Northampton & Peterborough Railway. This was a branch from the London & Birmingham Railway. We had double-faced rails, seventy-five pounds to the yard, jump joints, with wood keys outside, and all wood sleepers (ties).

From Peterborough I went to Accrington, Lancashire, and laid track on the East Lancashire Railway. We had double-faced rails, seventy-five pounds to the yard, jump joints with wood keys outside, all wood sleepers (ties).

After leaving Accrington I went to London and contracted to relay double track from Shoreditch Station to Stratford, on the Eastern Counties Railway, in the county of Essex. We had double-faced rails, ninety pounds to the yard; fifteen feet rails, jump joints, wood keys outside and wood sleepers, which were charred and tarred.

After finishing this contract, I contracted with the same company to relay one mile of double track on the North Eastern Railway. Here two holes were punched in each rail end and fish-plates were put on. This was the first experiment with fish-plates; they are universally adopted now. The first fish-plates were cast iron. Mr. Adams, of Old Ford Bow, Mr. Ashcraft, Superintendent of the Eastern Counties Railway, and myself, were the parties that first experimented with the fish-plates. Mr. Adams got the patent for the invention. This was in the fall of the year 1849.

In the summer of 1850, I laid double track through Copenhagen Tunnel, at the London end of the Great Northern Railway. This was my last work in England.

## INDIANA ENGINEERING SOCIETY'S SCRAP BOOK.

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To clean drawing use common wheat bread.

To prevent stamps from sticking together rub them on the hair.

To prevent ink from running after an erasure rub paper with the finger.

To prevent pen from skipping when making a tracing rub with powdered chalk or magnesia.

Excellent paper weights may be made from buckskin or chamois skin into the bags filled half full of shot.

Ammonia will greatly aid in cleaning pens after using Higgin's drawing ink, also use ammonia to thin Higgin's inks.

Large maps may be reduced in size by photograph for convenient pocket maps. The small figures are then read with a glass.

To make white lines on blue prints use a weak solution of carbonate of soda; also, to write white on blue prints or to touch up a poor print, mix oxide of zinc with water and add a drop of mucilage.

Respectfully submitted.

JOHN E. ALTER,  
THOMAS W. HUCKSTEP,  
L. A. BOSTWICK,  
*Committee.*



PROCEEDINGS  
OF THE  
FIFTEENTH ANNUAL MEETING  
OF THE  
INDIANA ENGINEERING SOCIETY,  
HELD AT  
INDIANAPOLIS, INDIANA,  
JANUARY 8, 9 AND 10, 1895.



## Summary of Proceedings

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COURT HOUSE, INDIANAPOLIS, INDIANA,

JANUARY 8, 1895, 2:00 P. M.

The Fifteenth Annual Session of the Indiana Engineering Society was called to order by President C. G. H. Goss, pursuant to notice and program, at 2:00 p. m., in the Court House at Indianapolis. The attendance was small.

The Secretary-Treasurer read his Annual Report, which, under the rules of the Society was referred to the Executive Committee.

The Chairman of Committee on Compiling and Publishing Annual Proceedings read his report. The report, on motion, was received.

President Goss delivered his address, which was listened to attentively, and received with plaudits.

Under the head of Miscellaneous Business the Secretary read a letter from T. W. Lawrence, Surveyor of Franklin County, referring to some needed legislation, and after some discussion of the subject, J. F. O'Brien made a motion to appoint a Legislative Committee.

Opinions pro and con were freely expressed, but the motion finally prevailed and the President appointed J. F. O'Brien, L. S. Alter, and T. W. Huckstep, as a committee to consider needed legislation on Drainage and Road Laws, for the benefit of the people of the State.

Mr. Alter, moved to adjourn until to-morrow morning at 9 o'clock. The motion carried, and the Society adjourned accordingly.

J. R. BROWN, Secretary.

## MORNING SESSION.

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WEDNESDAY, JANUARY 9, 1895, 9:00 A. M.

The Society met pursuant to adjournment. The attendance still small. The report of Committee on Drainage was called for, but the Chairman of the Committee being absent further time was granted in which to report.

A paper on Tile Drainage, written by James L. Romack, of Tipton, who had gone home, was read by the Secretary. A general discussion followed the reading of the paper.

The subject, Open Ditches, was next taken up, and L. S. Alter opened the discussion by giving dimensions for constructing open drains, and a general discussion was indulged in by the members present.

The President called on Mr. O'Brien to read his paper, but he, having left his paper at the hotel, was given time until the afternoon session.

Mr. Morrison made a motion to reduce the admission fee and annual dues to \$2.50.

A motion that Mr. Morrison reduce his motion to writing and present it to the afternoon meeting, was carried.

The Society, on motion, which was concurred in, adjourned until 2:00 p. m.

J. R. BROWN, Secretary.

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## AFTERNOON SESSION.

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WEDNESDAY, JANUARY 9, 1895, 2:00 P. M.

The Society met pursuant to adjournment.

Mr. Morrison presented the following resolution, to-wit:

*Resolved*, That the admission fee and the annual dues be reduced from five dollars to two and one-half dollars, and that the By-Laws be amended accordingly.

The amendment proposed in the foregoing resolution, after being submitted to the Society, received a two-thirds vote of the members present, and was declared duly passed.

J. F. O'Brien read his paper, "Speculation Based on a Theory of Proportion." The paper was well received and furnished food for thought outside of the beaten paths; but the subject treated, "Jupiter," being foreign to earth, not many present were prepared to enter upon any extended discussion as to relative proportions existing between Earth and Jupiter.

The report of the Committee on Highways and Bridges was called for, but Chairman Morrison not being ready when called, asked further time in which to report, which was granted. President Goss also requested Mr. Morrison to get newspaper reports of the Indiana Highway Improvement Association and embody them in his report.

The subject, "Brick Paved Streets," was called up and discussed to some extent by the members present.

The Society, on motion, which was concurred in, adjourned until 8:00 p. m.

J. R. BROWN, Secretary.

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## EVENING SESSION.

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WEDNESDAY, JANUARY 9, 1865, 8:00 P. M.

The Society met pursuant to adjournment.

L. S. Alter, Chairman of Committee on Instruments, Blanks and Records, read his report.

J. E. Alter read his paper, "A Plea for the Ponds of My Childhood." The paper was delivered in the German dilectic expression, was humorous in its nature and was enjoyed by all present.

Mr. Wagoner made a motion, which was concurred in, that the Executive Committee solicit contributions among the members present for next year's programme and hand the subjects of all promised contributions to the incoming committee.

J. F. O'Brien moved that a memorial be prepared and addressed to the County Surveyors and City Engineers, looking toward the establishment of an uniform system of

code of ethics and practice throughout the state, and that H. A. Fatout be made chairman of the committee. The motion was concurred in and the President appointed H. B. Fatout, J. F. O'Brien and N. A. Beck, a committee for that purpose.

On motion of J. E. Alter, the Society adjourned until to-morrow morning at 10:00 o'clock.

J. R. BROWN, Secretary.

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## MORNING SESSION.

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THURSDAY, JANUARY 10, 1895, 10:00 A. M.

The Society met pursuant to adjournment.

The report of the Committee on Statistics was called for, but the chairman of the committee not being present, no report was made.

The report of the special committee on Prof. Campbell's paper was called for, but none of the committee being in attendance at the meeting, no report was made.

The election of officers for the ensuing year was now taken up and resulted as follows to-wit:

President, C. G. H. Goss, Martinsville.

Vice-President, T. W. HUCKSTEP, Lebanon.

Secretary, J. F. O'BRIEN, Cloverdale.

Executive Committee.—H. B. Fatout, A. W. Smith and R. I. Morrison; *ex-officio* members, President C. G. H. Goss and Secretary J. F. O'Brien.

In compliance with the Constitution, President Goss appointed the following standing committees for the ensuing year, to-wit:

Committee on Printing.—J. F. O'Brien, J. R. Brown and T. W. Huckstep.

Committee on Damage.—L. S. Alter, J. L. Romack and R. I. Morrison.

Committee on Engineering and Surveying.—Charles L. Kinney, W. M. Whitten and H. H. Wagoner.



Committee on Public Highways and Bridges.—H. H. Wagoner, A. W. Smith and Geo. H. Champe.

Committee on Instruments, Blanks and Records.—T. W. Huckstep, R. A. Howard and J. W. Fawcett.

Committee on Statistics.—J. E. Alter, J. F. Meighan and C. E. Boulden.

Committee on Legislation.—J. F. O'Brien, L. S. Alter and T. W. Huckstep.

Upon the recommendation of the Executive Committee, the applications of Charles E. Boulden, of Frankfort, and W. H. Harris, Terre Haute, for membership, were voted on, and they were declared duly elected as junior members of the Society.

The Executive Committee who solicited contributions to our programme for next year among the members present, reported the following papers for the benefit of the incoming committee, to-wit: Brick Pavements, by H. H. Wagoner; Concrete Arches and Drains, by R. A. Howard; Old Field Notes, by R. I. Morrison; Drainage, by T. W. Huckstep; Gravel Roads, by A. W. Smith; Macadam Streets, by Geo. H. Champe; and J. E. Alter and J. R. Brown on subjects to be given to the Executive Committee before the programme of the next meeting is arranged and printed.

On motion of Mr. Morrison, a vote of thanks was extended to the Keuffel & Esser Co., of New York, and to Dennison & Perfler, of Columbus, Ohio, the two firms of instrument manufacturers who had their improved instruments on exhibition.

On motion of J. F. O'Brien, a vote of thanks was also extended to J. V. Coyner, surveyor of Marion County, and to the custodian of the Marion County court house, through whose kindness we were permitted to meet in one of the rooms of the court house in Indianapolis, and were made to feel at home.

There being no further business, the Society, on motion, adjourned *sine die*.

J. R. BROWN, Secretary.

## REPORT OF SECRETARY.

The report of the Secretary was read as follows and referred to the Executive Committee:

*To the Members of the Indiana Engineering Society:*

The undersigned Secretary-Treasurer respectfully submits the following report of the receipts and expenditures of the society since he has taken charge of the office at the close of our last meeting, to-wit:

|                                         |                |
|-----------------------------------------|----------------|
| To cash received from W. P. Carmichael, |                |
| Ex-Secretary-Treasurer.....             | \$45.68        |
| To dues from Mr. McCue.....             | 5.00           |
| "    "    J. E. Alter.....              | 5.00           |
| "    "    L. A. Bostwick .....          | 5.00           |
| "    "    Hiram Burner.....             | 5.00           |
| "    "    J. L. Romack.....             | 5.00           |
| Total.....                              | <u>\$70.68</u> |

## EXPENDITURES.

|                                           |                |
|-------------------------------------------|----------------|
| By cash paid Miss Johnson, Stenographer.. | \$12.00        |
| "    "    Expressage on Reports .....     | 1.50           |
| "    "    Expressage on Conn. Ex.....     | .50            |
| "    "    Postals, Printing and Postage.  | 4.00           |
| "    "    Programs .....                  | 2.75           |
| "    "    Railroad fare to Indianapolis.  | 2.60           |
| "    "    Railroad fare to Indianapolis.  | 2.60           |
| "    "    Railroad fare to Indianapolis.  | 2.60           |
|                                           | <u>\$28.55</u> |
| Balance on hand.....                      | \$42.13        |

Respectfully submitted,

J. R. BROWN, Secretary-Treasurer.

## REPORT OF PRINTING COMMITTEE.

*Gentlemen of the Indiana Engineering Society:*

The undersigned, Chairman of the Committee on Publishing our Annual Report, respectfully reports that the printing was delayed for several reasons. First, the stenographer was taken sick with typhoid fever and could not furnish the transcript of her notes in the early part of the season; second, several papers read before the Society were not handed over to me until late, and two of them are out yet; third, when I wrote to one of the committee to help solicit advertisements for the Report, his reply was that it was not his understanding that he was to help any. So the work rested solely on my shoulders.

The work of soliciting advertisements, compiling and publishing Annual Reports, is not an easy task at best; and when other obstacles are added, where the "cork-screw method" has to be applied before you can "make it come," it is a little discouraging; but if the members will bear with me a while longer, I will have the work completed or have printed what I have, whether it is complete or not.

Respectfully submitted,

J. R. BROWN, Chairman.

ADDRESS BY PRESIDENT GOSS.

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The report of the Executive Committee was deferred till later. The annual address of President C. G. H. Goss, of Martinsville, was then read as follows:

*Gentlemen of the Indiana Engineering Society:*

On the opening of the fifteenth annual meeting of this Society, I congratulate you upon the past success and the future prospects of our organization. The year 1894 will be remembered as a period of great business depression throughout this entire country. All branches of business, all trades, all professions have felt the effects of hard times. Engineering enterprises, always susceptible to the change of the financial barometer, have keenly felt the effects of the general depression, and as a result, many undertakings have received a severe set-back, and others have been entirely abandoned. Notwithstanding the unfavorable condition of business generally, municipal improvements in Indiana have advanced wonderfully during the past year. The same state of affairs that caused the abandonment of enterprises of many kinds made it possible for municipalities to make improvements at a cost much below the lowest hitherto known. After the first shock of the panic had spent its force, capital sought investment in municipal securities and our cities found little difficulty in bonding themselves to the limit at a favorable rate of interest.

Taking advantage of this fact, and the cheapness of labor and material, many of our cities are in position to build water supply systems, light plants, sewer systems, and to make other improvements, the cost of which in ordinary times would have been prohibition. Taken all in all, it is likely that the city engineers of our state have been as busy during 1894 as in any previous year. The engineer practising, generally may be excused when he envied the city engineer with their fixed salary during the past year, and perhaps the city engineer, more than at any other time in his life, was satisfied with his job.



Complaints of the over crowding of our ranks come from all quarters; more men than work is the cry. With hundreds of young men, graduates from our engineering schools, seeking employment, with little or nothing in sight, the prospect is not very encouraging. We all know that the demand for engineering work in our State is limited; more so, perhaps, than the importance of the State in other directions would warrant; but what can we do to increase this demand?

Can legislation increase the demand? If so, how and in what way? If so, how can the needed legislation be secured? This Society has had some sad experience in trying to promote legislation. To my mind, efforts at legislation will prove futile. I believe that the demand for engineering work will increase with the development of the State, and that it cannot be forced into a faster pace than this development will warrant. That there will be much engineering work done in our State is true, and that the idea that the successful development of the resources of Indiana depends largely upon the efforts of her civil engineers, will force itself to the front sooner or later. Meantime, we, as engineers, can do much to help this idea forward. We can be what we claim to be, civil engineers. We can do our work in such a way that it will convince and carry with it, the conviction that we are masters of our trade. When we plan a water supply system, we must know that it will supply. When we plan a drainage system, we must know that it will drain. When we plan a light plant, we must know that it will light. When we plan a bridge, we must know that it will carry the required load; in short, we must carry into our work the intelligent thought, the research, the tact, the ability that will make failure an impossibility.

This kind of work will do more to increase the demand for engineering services in Indiana than any possible legislation. In some localities in Indiana, there exists against civil engineers, a prejudice which amounts almost to hatred. For the reason of such a state of affairs I have no

sufficient explanation; it may be that in some cases individual members of our craft have given cause of offense. Surely we as a body, have offended no one. Ignorance, pure and simple, might explain the matter; but it is difficult to believe that in this land of free and liberal education, an ignorance could exist and manifest itself in a density that would prompt such feelings. It were more profitable, I think, to seek the cause of this prejudice in the fact that, in many instances, civil engineers have insisted that political jobbery in public work give way to intelligent, honest business methods. Broad and liberal minded people entertain no such feelings toward us; it is left for the flint-lock citizen, the jack-leg lawyer and the dog-fennel politician to heap insult and abuse upon a calling whose members, in point of intelligence and integrity, are already the peers of any set of men in the great State of Indiana.

The specialization of civil engineering has advanced to the point that now it is almost impossible to name an undertaking of any magnitude that is not in the hands of a specialist. We owe much to this specialist; his researches and experiments have done much toward our enlightenment and much toward elevating the standard of civil engineering. Granting all this and much more to be true, the question of whether or not specialization has been the means of advancing the material welfare of engineers is an open one.

Municipal engineering in Indiana, for many years to come, will, as a matter of necessity, be done by general engineers. The consulting specialist will be called in many cases, but the real "tug of war" and shock of battle will be borne by the all-around engineer.

It is hoped that the time will soon come when the engineering departments of the cities of Indiana will be divorced from politics and political demagoguery. It is hoped that our people will soon be able and willing to make a distinction between political intrigue, political favoritism and political dishonesty on the one hand, and straightforward business ability, uprightness and common honesty on the

other. At present, many of our city engineers are so hedged about with political ignorance and unbusinesslike influences, that it seems like an impossibility for them to do anything well.

Many of us who have been city engineers know what this kind of talk means. We have turned faint and sick at heart at the suggestions of ignorant Common Councils. We have tried patiently to bear the abuse and contumely of the idiot who cards the papers under the signature of "Tax Payer." Many times we have prayed that a thunderbolt of intelligence might strike our whole city government, including, especially, the City Attorney. We have argued, coaxed, begged of our authorities, to heed even to some extent, the dictates of experience and common sense.

A man willing to sacrifice reputation, judgment, and all convictions of right and justice would make a satisfactory engineer for some of our cities, his qualifications otherwise would not be taken into account. I do not charge these things to all of our cities. I am proud that there are some notable exceptions to the general rule. That there are exceptions is not to be credited to the system but to the intelligence displayed in some favored localities. It is not the intention of the writer to discuss the ideal engineering department of a city, its organization, or its authority, but that reform in this direction is needed is a fact too patent for discussion and too obvious for misunderstanding.

It would be, I take it, a waste of time for me to refer to engineering projects in other states and in other parts of the world, accounts of which are found in our current publications.

The greatest engineering problem of our state, the drainage of the Kankakee region, is still unsolved. The project of a ship canal connecting Lake Michigan with the Mississippi River has been the subject of much thought and discussion during the past year, and it is hoped that further discussion and investigation may result in action in this behalf. To the people of Northern Indiana this canal

project is one of very great interest in two directions. If, as indicated by Prof. Campbell, the waters of the Kankakee can be utilized to furnish the supply for this canal at its summit level, this fact may greatly assist in simplifying the problem of the drainage of the Kankakee lands. Aside from this large commercial benefits would accrue to the Northwestern portion of Indiana, from the building of the canal, and the successful installment of the enterprise would be a matter of great pride and much benefit to our entire state. Many inter-urban electric railway schemes are talked of in the state, and in some instances the schemes are discussed with a seriousness which promises action. With the improvements in and the cheapening of electrical appliances which are sure to come, many of these projected roads will be built, and in a much shorter period of time than we may imagine; our most important cities and towns will be connected by electric lines. That these lines will be profitable to their owners, and convenient to the cities which they connect, and to the country through which they run, there can be no question. This distribution of power by electrical transmission has turned attention to the utilization of water power and much activity in this direction is expected in the near future. The signs of the times point to material changes in the common road system of our state. Whether these changes will be made on lines indicated by good judgment and common sense remains to be seen.

The subject of ethics among civil engineers comes into the discussions of engineering societies. Not long since I was told by a member of the American Society of Civil Engineers, that there could be no code of ethics for engineers for the reason that civil engineering was not a profession. The further statement was that engineers were in the business for all the money they could get out of it, and this being the cases there was no reason for a professional rule of conduct, one towards another.

There is in these statements, nothing to speak of in the way of argument; it only shows that our eastern friend had



either become disgusted with the business, or had allowed himself to fall in with the prevalent idea of "everybody for himself and the devil take the hindmost."

But if these things be true, if our calling is such that in our business relation with one another, and with the public, there is no time, no occasion, no need for the exercise of the commonest kind of courtesy toward our fellow workers, and toward the public, then our calling is simply a trade, and like other trades we are fixed in position, and as in them, the successful individual is only an example of the survival of the fittest. I do not however take this view of the matter. I have always looked upon civil engineering as a profession. I have believed that it was a profession. I have thought of it as a profession having a code of ethics, a sort of unwritten law, enjoining gentlemanly and brotherly conduct upon its members. Surely a calling occupying a position inferior to none; a calling responsible for so many and so great achievements, a calling that has done so much for the material prosperity and comfort of humanity should be great enough, and good enough to say to its members you shall receive from your fellow engineer, fair, honorable and brotherly treatment.

During the past year civil engineering has securely held its enviable position among the professions of the world, and has kept fully abreast of the foremost column in the swiftly advancing army of knowledge and improvement. In the war that civilization wages against barbarism, the civil engineer is always found in the front of battle, and in the thickest of the fight. Forward! is the battle cry of the civil engineer. To batter down the walls of ignorance, to storm the citadel of nature's forces is his high ambition.

Fellow engineers, keep up the fight; go on conquering and to conquer, until all the subtle energies of nature are overpowered and brought chained captives to do your bidding, and to minister to the necessities and comforts of all mankind.

## TILE DRAINAGE.

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BY JAMES L. ROMACK.

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One of the most important duties of the County Surveyor in any part of this State is assisting in locating, surveying and superintending the construction of tile drains. There is said to be five hundred and twenty-four (524) tile factories in Ohio and six hundred and seventy (670) in Indiana, making about fourteen thousand miles of tile annually. Estimating the average cost of tile drains at sixty cents per rod, which would be too small, there is more than two and one-fourth millions of dollars spent in those two states alone, annually, in constructing tile drains, assuming that all the tile made at these two factories are used in these two states.

The County Surveyor usually assists to establish and surveys the main lines of tile drains. The farmer usually puts in the laterals without the assistance of the Surveyor. The Surveyor is expected to be better prepared to determine the size of tile necessary to furnish sufficient outlet for all the territory drained by the main ditch, and to establish the proper depth, to give all the laterals the required depth for good drainage, than the ordinary farmer or drainage commissioner. The selection of the size of the tile to be used, the establishing of the depth and distributing the amount of fall, is left to the Surveyor generally. We do not wish to add unnecessary expense by selecting too large a tile, nor do we wish to make a worse mistake by selecting too small a tile.

Farmers are tired of the inconvenience of having an open drain winding through their farms, giving them an unsightly appearance, cutting their fields in all shapes and losing the use of their best ground. Open ditches were

usually constructed in the channels made by the water, winding around trees, logs and other obstructions. It costs less to till a farm that has its fields in the shape of parallelograms than it costs to till a farm that has its fields cut in every shape imaginable by open ditches.

Open ditches are continually carrying the best portion of the soil. Construct a tile drain and the water in passing the pores of the ground to get into the tile, deposits this sediment that is carried away by open drains and renders the ground more fertile. Open ditches are a continual source of expense. The banks have to be mowed every year, and under our present law for repairing ditches, they have to be cleaned out as often as every two years. Bridges have to be built in order to cross them. We have tiled several miles of ditch that was formerly constructed as open ditches, and the work in that line is practically just begun.

There can be no fixed rule by which the exact dimensions of a drain tile can be determined. The conditions are so various, depending on the area drained, fall, quality of soil and the ever varying amount of rainfall. It will take a larger tile for the proper drainage of a tract of land that is basin-shaped and collects the water in pools, than it will for a tract of the same number of acres and the same amount of fall that has natural surface drainage. A portion of the surplus water will pass off over the surface and not injure crops. It will not take as large a tile where the country is thoroughly drained and all the laterals are in to prevent an overflow, as it will where just the main ditch is constructed and but few of the laterals. The ground being thoroughly drained from three to four feet deep, acts as a sponge and takes up the surplus water.

I surveyed a ditch that was tiled in 1889. We put in a mile and a half of eighteen-inch tile on the lower end and a mile and a half of fifteen-inch tile. The ditch was three miles long. We commenced the survey at the terminus of a tile ditch which was a mile in length, making the total line of tile over four miles long. There is over eight hun-

dred acres of land that drains through this row of tile. The ditch has been a success. It takes a heavy rainfall for the water to run over the surface of the ground and it gets away soon enough to prevent injury to crops. The farmers would not exchange the tile ditch for the old open ditch.

We have rains sometimes that we cannot hope to have a tile large enough to carry off the water as fast as it falls. I think it necessary to make provisions for heavy rain falls by leaving the surface of the ground trough-shaped over the ditch. This does not interfere with farming.

I have been recommending the following sizes of tile in the construction of ditches. I believe that an eight-inch tile with the fall of one-tenth of a foot to the hundred feet, and a good outlet with the laterals in, will afford a sufficient outlet for forty acres of land. That a ten-inch tile with the same fall and conditions will afford a sufficient outlet for eighty acres of land; that a twelve-inch tile with the same fall and under the same conditions will furnish a sufficient outlet for one hundred and sixty acres of land; that a fifteen-inch tile under the same conditions with the same amount of fall will furnish sufficient outlet for three hundred and fifty acres of land; that an eighteen-inch tile with the same fall and under the same conditions, will afford a sufficient outlet for six hundred acres of land. All tile from ten-inch up ought not to be less than two feet long. Tile of that length are stronger and lay better. Where there is a row of fifteen or eighteen-inch tile being put in, and the ditch is over five feet deep I think it would be better to put in not over three feet of dirt at first. Let this become thoroughly settled. I have known large tile to break down where the ditch was seven or eight feet deep, and the ditch was completely filled as soon as the tile were laid. Large tile ditches should be at least eight inches below the grade of the laterals. I would have the main ditch that much deeper than the laterals if did not have so much fall in the main ditch. The open ditches should be at least a foot deeper than the outlets of the tile ditches, and there should be a



stone wall constructed at the outlet of the tile ditches. This wall should be at least four feet high, two feet thick and started one foot below the bottom of the tile drain, and long enough to hold the embankment. This prevents the water from washing the dirt off the tile and filling the open ditch. One joint of regular sewer pipe ought to be used at the terminus of the ditch. All timber ought to be deadened at least twenty feet from either side of the tile drains. If this is not done the fine roots will enter at the joints, and the sediment will collect on them and completely obstruct the drain. I would not construct a tile drain by putting two rows of tile side by side. Those that have been constructed that way have not given the best satisfaction as far as I have observed. I would much rather have one row of twelve-inch tile than two rows of tens side by side, or one row of fifteen-inch tile than two rows of twelve.

Ditches in black land should not be less than three and a half or four feet deep. Tile laid deep will drain farther, a deeper bed will be furnished the roots of plants and cereals, less damage will result from freezing and drouth, and a greater bed will be afforded for the absorption of heavy rain-falls. Where ditches are put in on clay soils, and the ground is not so porous and "hard-pan" is near the surface, two and a half feet is deep enough. The ditches should be leveled by an experienced ditcher. If there is not water to level by, the grade can be cut by cross line. Give the contractor the number of inches to measure up at each hub stake so he can level a line across the ditch at each stake the same number of feet from the bottom of the ditch; then by using a staff the same length the lines are above the bottom of the ditch, he can get the exact grade at every point. Where the ditch is deep and liable to cave, you can get a better job without water than you can with it.

#### DISCUSSION.

J. Alter: He says he would rather have one twelve than two tens; that there would be such a difference in the carrying capacity. What serious objection would he raise that would overcome the difference?

L. S. Alter: In the first place there is practically no difference in the carrying capacity. In the next place the larger tile will keep itself in order better than the smaller one. In the next place it takes a much wider ditch and it is much more expensive to put in two strings of tile than one. And in the next place the cost of the larger tile would hardly be double the cost of the smaller one. So it would be cheaper all around and better when done.

John Alter: There would be nearly one-fourth difference in the carrying capacity.

L. S. Alter: I believe a ten-inch tile will carry a little bit more water than two eights.

President Goss: If there is such a difference I suppose it is due to the friction.

L. S. Alter: The eights have a frictional area of forty-eight inches and the tens have only thirty inches.

John Alter: I have heard an explanation like this, that the space between the two and below had a tendency to wash out.

L. S. Alter: I laid two fifteen-inch tile side by side. They have been in two or three years and there has been no place of that kind. I have never personally known of a case of that kind although I have often heard it urged. There is one more point in reference to the paper. I think his estimate of the area of the land drained is pretty low. We know that eight-inch tile in our county will drain more than forty acres, and ten will carry water off more than eighty acres, even where the drainage is only partially completed by lateral ditches.

President Goss: There is one other question in connection with the paper; that is, what the society considers the best practice in building a foundation for tile in extremely swampy ground or quicksand?

L. S. Alter: Well, I know in one or two cases in St. Joseph County, and in several cases in Cass County, they adopted the method of laying a board on the bottom of the ditch and laying the tile on the board. These boards will last for a long time, being almost continually submerged in water.

President Goss: How about the quick sand?

A member: Not being a member I will say that about twelve years ago I made a survey for a ditch cut seven or eight feet through a sandy place, and the gentleman that I did the work for got the pine board eight to ten inches wide and an inch thick and laid a row in the bottom for his tile. I have heard from that year after year, and it has been always a success. It was all sand, the worst bottom we know of for tile.

President Goss: It is the practice of some engineers in going through what we call quick sand, to place a board for the foundation and then fill the ditch with stiff clay on top of the tile for a foot or more, and then fill the remainder of the ditch with such soil as came out of the ditch. I know of some cases where that works very well.

L. S. Alter: I wish in connection with that to call attention to one method often adopted, and that is to use hay or straw. I have had occasion to find out that is a failure. The hay and straw on top of the tile will soon decay, and it is no better than the pure quick sand then.

President Goss: I think that is right and I think the process of tile on top to keep them in line is a failure also.

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## SPECULATION BASED ON A THEORY OF PROPORTION.

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BY J. F. O'BRIEN.

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On December 17th ultimo, I received a very urgent letter from our worthy President soliciting the contribution of a paper of some kind for this meeting, and in a postscript requested me to write upon the "Theories of the Proportional Universe," and informed me that either fact or fiction would answer, and having no other subject at hand upon which it would be appropriate to write, since nearly all other topics of interest to surveyors and engineers have been

pretty thoroughly discussed, and in no instance yet, has there been a perfect agreement. I have decided to act upon the President's postscript and contribute a paper based exclusively upon facts, excluding even the very appearance of fiction. In this paper it will clearly be shown that the planet Jupiter in particular, is the comfortable abode for sensitive and intelligent human beings.

It is a fact, demonstrated by mathematics, that spheres are to each other as the cubes of their like dimensions; now taking this truth as a text for further remarks, let us proceed to make a proportional comparison of Earth and its contents with Jupiter and its contents. The diameter of Earth being taken at 8,000 miles and that of Jupiter at 89,000 miles;  $8,000^3 = 512$  billions and  $89,000^3 = 704,969$  trillions; now dividing the cube of Jupiter's diameter by the cube of Earth's diameter the quotient is 1,377, nearly, thus giving the ratio of size of Earth and earthly things to Jupiter and Jupiterly things. It will at once be seen that the volume or bulk of Jupiter is 1,377 times that of Earth, and since all things on Earth are just exactly right, and Pope must have had this idea in mind when he said:

"In spite of erring reasons spite

One truth is clear—whatever is, is right."

By a little thought and investigation, it will be discovered that it is impossible to improve, in any respect, upon the work of nature as the same appears in this earth, and that a certain relation or ratio exist between and among all formed things, and that this relation or ratio is exactly right. Now let us cite a few examples to prove the truth of the above statements. Suppose wool grew on a tiger, what a jolly time the shepherd and shearer would have in raising wool and getting the fleece; or, suppose again that it grew upon the huge elephant, how would puny man get the beast on the shearing board to remove the fleece? A thousand examples might be mentioned to show "the eternal fitness of things." Now it remains to be stated that the things on Earth bear a ratio to the Earth itself. For the purpose



of making these comparisons, let us take the radius of the Earth as a standard of measurement in considering the elevation of things, and take the radius of Jupiter in measuring the elevation of things there.

Now we will state a proposition: If a man grew 5.7 feet high on a sphere having a radius of 4,000 miles, how high would he grow on a sphere having a radius of 44,500 miles? The salution is simple; as 4,000 is to 44,500 miles so is 5.7 feet to the man's height, or 63.4 feet. So your average citizen of Jupiter, to bear the proper ratio to his surroundings, must must be at least 63.4 feet high, and his weight, according to the rule for comparing his hight, will be about 2,200 pounds. His average life computed on the basis of the average life on this planet would be 392 years, and a real old man would attain the age of about 1,060 years.

Now to get a good view of the situation in Jupiter, let us conjure up an image of a land surveyor, or a city civil engineer, and observe his maneuvers a little. First, we notice a dashing young man about 325 years old and a little above the average height,—about 65 feet high—armed with a bright new Gurley transit weighing about 350 pounds, the legs of the tripod about 60 feet long, and a two-pole chain about 46,200 feet long and eleven marking irons about 15 feet long, together with a copy of the field notes in a book about 7 feet long, 4 feet wide and one foot thick. He is smoking a cigar 5 feet long and 10 inches thick. He carries his load and starts for his horse and buggy, stepping about 40 feet at a step. Let us notice the horse and buggy a little. The horse is a fine young animal about 65 years old and 55 feet high; the buggy has wheels 37 and 41 feet high and the tires on the wheels are 14 inches wide; the bed of the buggy is 65 feet long. Our dashing surveyor mounts his gig and drives away down the gravel road, the gravel on which is 11 feet deep and 330 feet wide; the grade of the road is fine, it having been brought to a two-degree grade. The horse goes at a merry clip, taking long and rapid strides; his speed is so great that he would distance Robert J.

As our hero spins along he notices the fence along the road side, it is 45 feet high and built of rails 110 feet long. The forests are in full foliage and the tallest trees lift their heads 3,500 feet high, and upon their twigs are bevvies of little birds singing in chorus sweet and clear, and the largest of these happy songsters is  $6\frac{1}{2}$  feet high, but on he passes, giving those things only a passing glance for to him they are an every day sight. As he rushes on he passes blooming fields of golded grain,—on his right hand he notices a thrifty farmer as he enters with his electric twine binder, a quarter section containing 224,000 acres of wheat. The wheat is very fine, the stalk being 50 feet high and the grains being fully  $1\frac{1}{2}$  inches long. Our surveyor guesses the field will yield 4,400 bushels to the acre.

On the left hand he notices a fine blue grass pasture in which are grazing about 100 fine 44-year-old steers, each about 50 feet tall. Our surveyor guesses that when they are ready for market that they will weigh about 22,000 pounds. On he goes till he reaches the river,  $5\frac{1}{2}$  miles wide, over which he crosses on a Whipple truss steel bridge (built by the Brackett Bridge Co.). Our surveyor being somewhat interested in engineering, stops to examine this structure. He sees it consists of one span divided into 100 panels of 290.4 feet each, and the depth of the truss 473 feet, or equal to about one-sixth of the span, and a 220 foot roadway. And then making a few measurements and calculations, he finds it is proportioned to carry a moving load of 7,260,000 pounds per lineal foot of roadway. But as time is fleeting, our surveyor bethinks himself that he must not tarry or he will get to the old man Omricron's in time for dinner, as he has yet about 120 miles to drive, but by diligent driving he soon got there, just in time for dinner.

Mr. Omricron is a patriarchal looking gentleman about 780 years old, he wears a distinguished looking white beard 11 feet long and gold-rimmed spectacles, the longitudinal diameter of whose lenses were 14 inches long, and was dressed somewhat after the fashion of a country gentleman.

His house, a stately old mansion, two stories of a 100 feet each high, was snugly nestled away among a clump of deciduous trees, somewhat resembling the Norway pine, about 3,000 feet high. Here Mr. Omricron was born and had dwelt all the days of his short life. He had married when he became of age (231 years) and now had an interesting family of 33 children, all of whom were married except his youngest daughter, Miss Cassiopeia, who was a handsome young lady 176 years old; just at that stage of existence which, in our planet, corresponds to sweet sixteen. She was a remarkable handsome girl, and a brief description of her may not be out of place. She was a bright blonde, of a tall and willowy build, her height being exactly 61 feet 6 inches, and her weight 1,540 pounds; her hair hung in graceful curls down her shoulders a distance of 20 feet. She wore an elegant blue satin dress containing about 325 yards. It was made in the latest fashion, with "leg of mutton" sleeves; her dainty feet were incased in a pair of elegant white satin slippers, size No. 44. She was standing on the varanda feeding a beautiful canary, a bird about the size of an American buzzard. As our surveyor approached the house she struck him as vision of beauty. Mr. Omricron introduced our surveyor, Mr. Orion Draco, to his daughter, after which they proceeded to discuss the elegant and savory dinner which the good Mrs. Omricron had prepared. The dinner was served on a table 27 feet high and 66 feet long. The dinner consisted of a spring chicken, *a la fricassee*, that weighed 44 pounds; porterhouse steaks, each weighing 10 pounds; tomatoes, 32 inches in diameter; potatoes, weighing 9 pounds each; with hot rolls, 30 inches in diameter, together with a conserve of fruits and jams to correspond, and coffee served in cups that held a gallon each.

After dinner was over, Mr. Omricron brought out some cigars 5 feet long and worth \$1.10 each. Our surveyor then went out and made the survey for Mr. Omricron, to determine who was the proper owner of a fine tulip tree that

stood near his line. The survey gave the tree to Mr. Omricron, which so pleased him that he offered to pay the surveyor his fees as soon as the line was finished. The surveyor told him his bill was \$133.00. This somewhat surprised Mr. Omricron, but when the man of brass itemized the bill as follows:

|                                |   |   |   |          |
|--------------------------------|---|---|---|----------|
| Running line, -                | - | - | - | \$ 11.00 |
| Mileage, 240 miles at 55 cts., | - | - | - | 122.00   |

With no charge for swearing assistants, he paid it, complaining that the fee and salary law ought to have reached his case. Mr. Omricron being a strong advocate of the Populist doctrine, had a constitutional antipathy against fees and salaries in general.

By this time the shades of night began to fall, and Mr. Omricron extended a very hospitable invitation to Mr. Draco to remain over night with him, which was gladly accepted, as our surveyor was smitten with the charms of the young lady, and this would give him further opportunities for cultivating an acquaintance. The advances made by our man of brass were kindly reciprocated by the coy maiden, and they soon arrived at a happy understanding.

Mr. Omricron came in for a share of Draco's attention. He asked him if had ever read or heard anything of a little planet called Earth, to which Mr. Draco replied that he was quite familiar with that little midget of a planet, having made many acromatic telescopic examinations of it, and that he had discovered its true size and distance from the sun; that its mean apparent diameter was 3.43 seconds; that its real diameter was about 7,916 miles. Its mean distance from Jupiter was about 450 millions of miles. Then he had frequently computed the distance as follows: From the extremities of a known base line, the angles which the visual rays from the planet form with it are measured, and their sum subtracted from angle of  $180^{\circ}$  gives the angle opposite the base line, then by trigonometry, all the angles and sides of the triangle are computed. The angle under which the base of the triangle is seen from the planet is the parallax of the planet.



Miss Omricron, not caring to hear Mr. Draco pronounce a discoursed upon so stale a topic as mathematics, asked him what was his opinion as to whether the planet Earth was inhabited by sentient, intelligent human beings?

He replied that there was certainly no living creature on the Earth, as it was most assuredly so hot there that even a salamander could not exist.

Before leaving the Omricron family we will state, in proper season, Mr. Draco and Miss Cássiopeia were happily married, and that in about eight years she presented him with a little pledge of love in the shape of a bouncing baby boy, who at his birth was about 15 feet long and weighed 132 pounds.

Now in conclusion, I will state that there are far more reasons to believe the doctrine of the plurality of worlds than to disbelieve it. It may be suggested by some skeptic, that since Jupiter is so far removed from the sun, the source of light and heat, that it would be too cold for a home for sentient, intelligent human beings; but my answer to this is, that it would not be any more difficult for the designer and constructor of this planet to make a Polar bear, that delights to live amid the icebergs and perpetual snows of the Polar regions of our planet, than to make the rhinoceros and alligator that delight to bask in the burning sun of the tropical regions of our Earth. Nor would it be any more difficult to do either of these tasks than it would be to create a grade of life that would be appropriate to the conditions that exist in Jupiter. To dispute these facts will be to impeach and impugn the wisdom and greatness of the author of our earth and our very existence.

It must not be argued that the planetary system was created without a well defined purpose in view; and since the object would not be to afford light to the inhabitants of this Earth, because had light been the object, an additional moon could have been made to shine while our other moon was not luminous, which would produce a very much more brilliant light than that afforded by the stars and planets

combined. It is a fixed principle of solar and celestial science, that larger heavenly bodies do not revolve around the smaller ones, but that the reverse of this is true.

This paper will, no doubt, be criticised for not comparing weights according to the rule for comparing spheres. Those who wish to ascertain the specific gravity of a citizen of Jupiter can do so by this formula:

$$4,000^3: 44,500^3:: 150^{\text{lbs.}}: X.$$

As a matter of fiction, as taught astronomical literature, an object weighing one pound at the equatorial regions of Earth would weigh about  $2\frac{1}{4}$  pounds if removed to the surface of Jupiter.

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## DISCUSSION ON THE SUBJECT OF BRICK PAVED STREETS.

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President Goss.—Has any member of the Society had any experience in building brick streets on gravel foundations.

Wagner.—I think a gravel foundation is all right, but putting gravel on a clay foundation, I should think, would be a very risky way of working, unless you fill the spaces between the brick to keep the water out of the foundation. In all the work I have done in brick paving, we used a paving tar cement and filled the joints with it, then the brick pavement acts as a roof and there is no water gets in the foundation at all. We dug up foundations this winter that had been down a year and they were just as dry as they could be, and the earth foundation was so solid that it was almost like it was frozen. You can not sink a pick more than two inches in that foundation, it is so solid. Another thing I wish to say is about material. I think that a great many cities make a mistake in their materials, and while the foundation may remain in good condition, the material with which the pavement is made is, in a great many cases, defective, and makes a bad street. It has not been over

five or six years since there were no brick streets in this part of the country, either in Indiana or Ohio. However, I have been in several cities where brick pavements have been made and I have found that the greatest fault has been in the selection of the material.

Smith.—Do you use a glazed brick or not?

Wagner.—No, it is simply vitrified and not soft glazed.

Smith.—The soft glazed brick is one of the poorest things that can be used. After a while the surface becomes worn off and they hold water like a bucket, and the brick decay.

Wagner.—May I say a word about the moisture? The trouble with glazed brick is that you can't tell a soft from a hard one. In unglazed brick you can. I don't believe there are a thousand brick in our streets that will take an ounce of water since we have learned the difference between good and bad brick.

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## ON SHIP CANALS.

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BY PROFESSOR COLLETT.

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A committee composed of four members of this Society called upon Prof. J. A. Collett at his rooms, on Illinois Street, and the following conversation took place:

President Goss.—Prof. Collett, we have been discussing the question this afternoon, of a ship canal connecting the lakes with the Mississippi River, and we have come over to see if you could say anything of interest on the subject.

Prof. Collett.—Twenty years ago, I was earnestly in favor of a ship canal from Lake Michigan down the Wabash to the Ohio; and, of course, a man has no right in science to guess, or think, or believe anything and talk about it. The only way to do in the world is to *know*, so when I say I guess a thing, or believe a thing, you need pay no attention to me; but if I *know*, then you have something to rely on, and I *know* it would be a great advantage to the State or Indiana,

and especially to the northern part of the State, to have such a canal, and opening navigation by way of the Iroquois River to the Wabash. The Indians pronounce it Wabash, and if you catch any old grizzly headed Indian he will call it Onabauch. At the time of the fire in Chicago, I went there to see the ruins first; second, I took my barometer along with me to survey the canal that I wanted to build. Carrying my level at low water mark at Lafayette on my barometer, I went over the ground first, and found that there was a rapid ascent to the Kankakee, and to the dividing line between the waters of the Mississippi and Lake Michigan and the waters of the St. Lawrence, and when I got to Lake Michigan I found the low water mark there, and found that the depth of the canal would require an excavation of 180 feet as the dividing line of the summit between Lake Michigan and the Tippecanoe or the Kankakee. That was the first difficulty in the way with hard cutting even on that.

Second, there is a fall of three or four feet to the mouth of the Tippecanoe River, which is bedded part of the way on solid rock, and consequently the whole bottom of the Tippecanoe River, so bedded in solid rock, would have to be taken out. As I returned, I found that low water mark at Lafayette required an excavation of the Wabash of 24 feet to the low water mark of Lake Michigan, not including the depth of your vessel or boat, and as there was a fall of the Wabash of nine inches to the mile from Lafayette to Terre Haute, and one-half foot from Terre Haute to the mouth, why it would require an excavation nearly the whole length of the Wabash for the canal, and finally as the Wabash in low water is as large a stream as the Ohio, the ship canal would have to be excavated to the mouth. The canal would therefore require an expense of digging and lockage greater than the Suez canal and almost equal to the Panama canal. Of course I concluded at once I would abandon that canal; that it could not be built; it would cost too much to build it and it would not pay expenses after it was built. However, on the other hand, with lockage, a



canal can be brought from Lake Erie to the Wabash. It would require slack water navigation the whole length of the Wabash, or at least, below Grand Rapids, in Posey County. The government is improving Grand Rapids, or trying to, by digging out and blowing the bottom of the river with dynamite. They used a great deal of dynamite. Prof. Cox and I were there and the superintendent showed us where he had laid a line of dynamite, and you ought to have seen Prof. Cox walk on tip-toes for fear he would tread on a little dynamite, but I was so enthused seeing what I wanted to see, and by thunder I was going to see it. Ages ago, many years ago, which may be measured by millions and billions of years, the table land on the northeast corner of North America—Labrador, and then Canada and then New England, was 2,500 to 3,000 or 4,000 feet higher than now. The gnomon, measure of the height of the ice and water, is on Mt. Washington. As you come down from the summit in a wagon, on the north side you see the tops are covered with sharp angular rocks. I, all the time felt as though I wanted to hold on when the wind blew round us as we came down, but I saw all at once, on the shelf of the rock, a rounded rock—a boulder—about ten inches in diameter. I halloed to the driver, "Stop! Stop! every one of you, see there! We have seen angular rocks about here, but there is a rounded boulder. That is the measure of the highest reach of the ice and the overflow of the water."

That water, you know, was 1,200 or 1,500 feet above the level of the ocean, and at that time the pitch of the land was back to west and southwest, and the St. Lawrence River ran up stream, as you will see by the current of water running against an obstacle and leaving a drift lodgment below. That great flood of that long time ago washed out the St. Lawrence, dug out Lake Ontario and dug up some of the rocks which you will find if ever you go to Lake Ontario, and which are called by the Indians, Oris Kand. You can get them there by the car load; you occasionally find them in Indiana. They were dug out of Lake Ontario and came on

clear over here. They are flat rocks, rounded and chiseled without turning them around and flattening them. Afterwards, it flowed on to the west and dug out Lake Erie. You don't have to guess at it. When you go to Middle Bass Island or to Kelley's Island in Lake Erie, you see as the shore lines and the under water are plowed by the rocks that were fastened in the ice flow for miles and miles and unmeasured depths in the water, you know; you don't have to guess, you know that the current was from north  $80^{\circ}$  east to the south  $80^{\circ}$  west.

President Goss.—Will you please go on and state how the two glaciers came together?

Prof. Collett.—The northern glacier came down and obstructed the flowing of the eastern glacier—you know north  $80^{\circ}$  is nearly due east. Before that, if you will take a post-office map of the United States, you will see that nearly all of the old ancient lines of railroads, canals and rivers ran south  $75^{\circ}$  to  $80^{\circ}$  west. You don't want an ordinary map; you want one that has only a few towns on it and a few railroad marks. There was a mighty sluiceway at that time ran and dug out the deep channel of the Kankakee and Iroquois, and also Blue River and other streams in Indiana. You can see them in Michigan and Wisconsin on that post-office map. The northern drift came digging out Lake Michigan and filled up and packed away and made the Kankakee swamp and the Iroquois swamp, and in Newton County, the drillers there have developed the fact that the ancient channel of the sluiceway of the drift was 110 feet deeper than the bottom of the Iroquois River, and the same development would be found in the deep bores along the whole length of the Kankakee, and so that sluiceway came down here, but the northern drift came and jammed it back, so that all central Indiana was the bottom of a lake, and all northern Indiana was the bottom of a lake 300 to 500 feet higher than the level of Lake Michigan is now. You have to go over the ground to know all these things as I know them and I keep my eyes open all the time. My family

have been surveyors for 200 years. John Collett ran the dividing line between North Carolina and Virginia. My grandfather was a surveyor in the Maumee swamps in Ohio, and my grandfather, father and uncle surveyed here in central Indiana for the United States in 1816 and 1818.

Well, the northern glacier digging out Lake Michigan obstructed the Kankakee and Iroquois Rivers and pushed on down and obstructed for a while the Wabash River below Lafayette at Black Rock and made the great Wea Plains and the Shawnee Prairie. Haven't you often wondered how those great gravel beds got there—the Wea Plains and Shawnee Prairie, and in coming down from Lafayette to Crawfordsville? Sugar Creek ran about two miles north of where it is now and the glacier pushed the hill down and jammed it and made a lake down there so that the overflow had to get discharged by cutting a new opening. Before that Sugar Creek used to run due west from Crawfordsville, but this made it cut a new channel. I know it because a bare rock is a wound on the breast of nature and she attempts to cover them over as soon as she can, with dirt and clay, etc., and in the course of time she does slough it down and cover it over, and so I knew in going down there that the lower part of Sugar Creek was a new stream only a few thousand or a hundred thousand years old, just as I knew when I went down below Louisville. I knew that the Ohio was a new stream because to follow along that hollow the banks were precipitated and I discovered a great river 17 miles wide and 450 feet deep, but I could not find the outlet. I went and hunted west, no outlet; southwest, no outlet; south, no outlet. I had almost concluded that I would never be able to find this outlet. They had reported in their geological reports of Kentucky a great monster bed of potash and I got a man to go with me with an old wagon and a grubbing hoe, and to take me to the very spot where the Kentucky geologist got his sample. He said, "Here." I said, "I don't want that, I want a sample of this stone and rock. We have thousands and thousands of it in Indiana, and if I can get

18% of potash out of that Indiana is the wealthiest state in the world." He said, "You have it right here, that loose stuff." I could see that a fire had gone through the woods and their potash was the burned stuff washed down in the little run.

I was disgusted and went back to town and was waiting for the train; the county judge and county officers gathered around me and wanted my opinion of the Kentucky fertilizer. Says I, "Gentlemen, I am working for Indiana; I am not working for Kentucky. Indiana engages all my attention and all my mental effort. I have been in Kentucky enough to know that if you have a bull or a horse that you brag on and I interpose, then I have either got to shut up or fight. It is the same way with a sow, hog or sheep," and says I, "You are all tall fellows and I can't whip you all and therefore, I don't want to fight and I don't want to express an opinion, as it is not favorable." "Well," says the judge, a great big tall fellow, "We won't fight, but we want your opinion." I says, "Your fertilizer has no potash in it whatever. It is of no value. No living plant can live on it and no animal can live on it. Says he, "We found it all out ourselves." I went down to Grayson Springs, Kentucky, and had a 4th of July, and it was a barbecue and they had a high old time and got to fighting and quarreling, and one of the finest looking men you ever saw, an old, grey-bearded fellow, tried to make the peace, and one of the drunken boys ran a knife into him and I concluded—you know I am a Presbyterian and we are peaceable folks, and we won't fight at all unless somebody tramps on our toes or knocks a chip off our shoulders—well, I went down to the railroad with my level in one hand and my barometer in the other, terribly disgusted and looking for my old river. It was the roughest place in the world and terrible rocky, and the conductor halloed out, "Grand View," and I said, "You must be hard up for names in this country;" and an old hump-backed, pigeon-toed fellow says, "Stranger, look over there and you will see something that is a grand view." I looked, and



there was the bed of my old river. It had jumped over to where Nolin Creek now is. I went down the railroad and I met an old negro with a bucket and a scoop shovel, and his clothes were all muddy, and I says, "Are you a well digger?" and he says, "Yes, Massa;" and I says, "You are the very man I want to see;" and I found out that he had dug fifty or sixty wells along there and he said that he dug down to sand and gravel. The Kentucky geologists had declared there wasn't a bit of gravel in Kentucky. So I knew there was the place where my ancient river had been, and I walked across the railroad and went down to the Mammoth Cave, staid all night, and the conductor was the only gentlemanly conductor I ever saw; and he saw my instrument and that I was watching, and he told me that low water mark above the falls was on a level with the foundation of a bridge on Nolin Creek; and coming up in the morning he only had a few passengers, and as we came to Nolin water station there wasn't room for a little narrow street, and the railroad occupied all of it except the sidewalk, and it was raining and we only had a short stop, and I looked out and there was gravel sidewalks way down there in Kentucky. I got out and took my knife and got down on my knees in the mud and went to digging up the gravel and stones and putting them in my pocket; and a great big, tall, knock-kneed fellow says, "What are you doing thar stranger; digging for gold?" Says I, "No, for greenbacks." He says, "You'll not find any thar." I said, "I am finding greenbacks all the time." I said, "Here is the glacial drift that came from way up north." He said, "There is plenty of gravel on the side of the hill," and I said, "That is where the pre-glacial river ran." In tramping over the country I found that the J. M. & I. R. R. ran down a great valley with bluffs on each side four or five hundred feet high and ten or twelve miles wide. This was the path of an ancient river. In digging wells in Clark County, they have found boulders and gravel.

I was telling you about Sugar Creek. The glacier from Lafayette came down and dammed Sugar Creek and made a lake of nearly all of Montgomery County and compelled Sugar Creek to get a new channel. It did get a new channel, and what was left there was called Lye Creek Swamp, and they had some of the most ridiculous bills in the legislature; but at last they got some bills through and they spent four years trying to drain the swamp up stream. This great glacial drift was seventeen miles wide and 450 feet deep.

John Alter: You say the general trend of this drift was southwest from Lake Ontario and Lake Erie.

Prof. Collett: The original first drift was from the east or to the southwest. Afterwards it was from due north, and then after a long period of time the pole of the earth changed and it was from the northwest. The scratches and marks on the rocks tell the story.

John Alter: I know where the marks are in our county and they are from the northwest.

Prof. Collett: What county?

John Alter: Jasper.

Prof. Collett: They are from the northwest and you know it. You know a boulder weighing 98 pounds was found at Danville, Ill. It couldn't have come from anywhere except from the copper country of Lake Superior. □

President Goss: The glacier that came from due north when it struck the hills of Brown and Morgan Counties separated or divided?

Prof. Collett: It divided and part of it went down and cut a new channel, or a new river through Owen County. A part went by Bean Blossom. The main flood went through the Collett glacial river and down to Seymour, and passed what is now White River and went on through Clark County to the Ohio River and Louisville. Now when Lake Erie sluiced down here, the streams were big in the spring and summer. When these streams froze over, more space was occupied and the drift pressed through the gold-bear-

ing region, and therefore you found gold on lower White River, and especially at Bean Blossom and at Centerton. It was brought down and deposited all over southwestern Indiana. Sometimes this gold is in the form of little nuggets and sometimes in flakes as large as a grain of wheat. It is most abundant in the region of Centerton and then south on White River, and it is often found quite abundantly on Bean Blossom, in Brown County. I will hazard the opinion that there is enough gold buried under the sands of Indian Creek to pay off the United States national debt, but it will require \$1.50 to \$2.00 worth of work to get a dollar's worth of gold out. On Bean Blossom, a man can make 75 cents a day, winter and summer, getting out gold.

The Reporter: Were did the gold come from?

Prof. Collett: It was brought there by the glaciers. The glaciers that brought the gold also passed over other treasure land, and near Martinsville three diamonds have been found—two first-class water diamonds—gems, and one slightly clouded.

John Alter: You have made the statement that it was impracticable to make a canal from Lake Michigan south on account of the depth of the cuttings.

Prof. Collett: Yes, and the digging up of the bottom of the Tippecanoe River and Wabash River to near Terre Haute.

John Alter: Well, now wouldn't the cuttings be nearly as deep on the other route, although the stones are not so bad?

Prof. Collett: O, no. It would be nearly level right down. The water ran south from Lake Erie principally to the Wabash. It was a mighty river in the spring and summer and it flooded a plain eight or ten miles wide, leaving banks of gravel on each side, and in the winter it was reduced down to the size it is now, but running at a depth of one hundred feet below where it now runs.

The Reporter: When was that?

Prof. Collett: A few million years ago. The Lafayette well proves by the sand and gravel that the bottom of the Wabash was sixty feet below the level of the court house and at Terre Haute eighty feet.

The Reporter: How do you know?

Prof. Collett: Because you find sand and gravel. God Almighty don't make sand except by natural agencies. I said to a stranger in Pike County that a bed of gravel is better than a gold mine. He asked me where it came from. I said, "It was brought here by the ice drift." He said, "I don't believe it." I said, "How do you suppose it got here?" He said, "God Almighty made it here and put it here for our use." I said, "Wouldn't God Almighty be in little contemptible business rolling gravel stones and carying them in His apron and dumping them here for such cusses as you and I." "Well," says he, "I had not thought of it in that way." Says I, "Think of it a moment and you will never venture such a ridiculous idea again." At the close of the glacial age this country was flat and level and the sluice ways were formed all over it. A great bed of those geodes were found at the White River. They called it gravel, but as soon as I went there I said, "They are geodes." Our sulphur wells in Indiana are the best in the world medically. There is no half way business about that. They are the best in the world for dyspepsia, liver complaint and diseases of the blood, and they have wonderful efficacy in the treatment of diseases peculiar to women. Eel River, down in Owen County, is a little shallow stream, but it once flowed at a level of one hundred and ten feet higher than it does now. Gold is found in all the counties in small quantities, southwest of White River. Flake gold, powdered gold and some nuggets have been found in Gibson county, but so deep down in the ground it would cost ten dollars to get a dollar's worth out.

The pole of the earth has changed, and not only depressed Labrador and Canada, but the process is still continuing. The boat-houses of the missionaries at Greenland that were



built one hundred years ago are now four feet under water. The old fences in New York and Brooklyn built by the early settlers are now from twenty-eight to thirty-two inches lower. The process had been continuous for a long time, and along the coast of New Jersey they have found fresh water shells on the shores of the ocean at great depth. South Carolina has been depressed within almost a historic period so that you can find eighteen feet below the surface the roots of the cypress tree that can only grow in the air. We, here in Indiana, are moving toward the north pole at the rate of nine or ten inches in one hundred years, and sinking probably five to twelve inches in one hundred years. This process of uplifting and depression to the north first sent the St. Lawrence River up stream to the ocean. The Red River of the North used to run south to the Mississippi; It now runs to Lake Winnipeg. The Illinois River flows with very slight current and it is uncertain which way it wants to flow; so is the Maumee. It is a currentless river in Ohio, and at times it is almost stagnant it is so doubtful which way it wants to flow. The St. Joe and St. Mary's River at Ft. Wayne show that they intended to run down south, but the depression of the north changed that. The Maumee runs up stream where it used to run down stream from Lake Erie. It would be an easy task to deepen the Maumee for vessels to pass up, and the cutting would not be but very little the whole way until the current is established again, down to the Wabash. Then the cutting—it would not cost more than ten times as much as the old canal did to make a ship canal, say 15 or 20 feet deep, but in time of low water the Wabash would have to be dammed and slack water over the ripples that are near Golconda, Ill. The project is entirely feasible, but the certainty that it would not pay until the railroads are abolished except in time of war.

A letter was read by the Secretary, from the County Surveyor at Brookville, as follows :

BROOKVILLE, IND., Jan. 4, 1895.

MR. BROWN.—*Dear Sir:*—Your card of invitation was received late on Saturday evening last. I regret that the time is so short that I cannot make the necessary arrangements to attend the meeting. There are several business matters which, perhaps, should come before the meeting. I will mention one or two.

In this county, and I suppose it is the same in other counties, we have a number of ex-county surveyors who have kept their instruments. They run lines and plant stones for corners without field notes, etc., and thus deprive the County Surveyor of many dollars in fees which should be justly his. Why should ex-surveyors continue to perform the duties of the office they held, any more than any other county or state officer? I hope your Society will call the attention of the Legislature to the subject, and that a law will be enacted that will prohibit any one except sworn deputies from interfering with the duties of the County Surveyor.

Again, I think we should have a law declaring that when a deed describes land by Government survey, that the established section or quarter section line should be the line between the farms. Let me illustrate: A man owns a quarter section of land in this county, and puts a fence through it east and west. He afterward sold the north half of the quarter to one man and the south half to another. A surveyor was called and the fence was found to be about one rod south of the middle. Quarrels ensued, the man on the north claiming to the fence. The property changed hands two or three times, with a constant hard feeling between the owners, until at last an honest man got the north half, who said he only wanted the half of the quarter. I was called and divided the quarter in two equal parts, and now there is peace. There is now a lawsuit pending in our Circuit Court, in which a man claims a strip more than two rods wide in an

adjoining section, just because years ago the man in that section did not set his fence to the line, and in kindness permitted the man to join a fence to his. I think some legislation is necessary on the subject. Again, I think that the commissioners should be compelled to furnish the surveyor all his instruments and an office. They do not do so here.

T. W. LAWRENCE.

DISCUSSION.

L. S. Alter: Some of the points mentioned in that letter have been pretty thoroughly discussed in this society before. One of them is the difference between land ownership and the section line. Surveyors should only locate lines and let the owners and lawyers fight the question of ownership. The surveyor has nothing to do with the title to land. As to presenting a petition to the legislature, I think many of us understand about what effect that would have upon the legislature. Of course we should agree on about what we want and then let each member see his representative or senator and present his views of the matter personally, and not as the representative of any society.

Mr. Morrison: I don't want to say anything particularly about this case except to say that Mr. Alter is right in saying it has been thoroughly discussed before. This point which he makes about the division quarter was decided by the Supreme Court and in a case where there was one man got thirty acres off the north half and the other got fifty acres off the south half. The land was sold that way and mortgages were foreclosed and there was found to be a strip in the middle of over an acre. Who did it belong to? They had a law suit and it was finally carried up to the Supreme Court, and the Court decided that it did not belong to either one of the parties; that the strip in the middle belonged to the original grantor.

Mr. O'Brien: That part of the subject considered by the letter relating to the ownership of land is one that I will speak of a moment. Where there is a dispute as to the title to land it can not be decided by the County Surveyor, or

any other surveyor. That is a matter that comes exclusively under the jurisdiction of the Court. The surveyor cannot go out and establish property lines. He simply goes out and runs government lines or retraces them. Mr. Alter and Mr. Morrison are both correct on those points. Another point that I wish to mention is the propriety of passing a resolution or presenting a petition to the State Legislature confining the surveys that are to be made in the State to men who hold a commission. I remember when I was a great deal younger than I now am that I made a talk in line with a part of that letter. I thought it was an outrage that I should not be able to go out and survey all the lands in our county. I studied that over about ten years and I have decided that it is perfectly right and correct. Putting a part of the President's address in connection with this letter, we have about this result: surveying is not a trade. Any man can follow a trade if he learn it. Surveying is a profession; medicine is a profession; theology is a profession; the law is a profession. Any man who prepares himself to follow one of these professions has a perfect right to work in that line. This society ought to have a legislative committee and ought to unite on some points of legislation. But they should not unite upon anything that would leave the average legislator to think that there was sinister motive as the basis of the union upon that topic.

Mr. Romack: I don't believe anybody has the legal right to establish a corner except the County Surveyor, or his sworn deputy, under our present law, if I understand the law.

President Goss: I do not agree with Mr. Romack. I believe that any man whether he be competent or incompetent, black or white, or any other color can go out if the two men who own the land are willing, and establish a corner, and it will be just as binding on those two parties as any man's county survey can possible be.

Continuing Mr. O'Brien's argument a little further in regard to the ethics of the profession. I think he is right about that; that any man who is competent should have a



right to follow his profession, and should be protected in that right, in any case or under any circumstances he may see fit. But I do believe one thing, gentlemen, I believe that the law affecting the County Surveyor needs some changes, and I am not right sure as to whether it needs changes or whether it needs to be entirely done away with. My honest conviction is that it would be better, everything taken into consideration, and everybody concerned, if the constitution were amended and the office of County Surveyor was abolished in the State of Indiana. If that is not done then we ought to have some system by which county surveyors can be regulated. I don't mean to regulate the surveyors either, but the way they get into the office. I do not believe that any county ought to be allowed to take up some man who has no knowledge of the business, a man who has never prepared himself for it in any way, shape or form, and put him into an office, the duties of which are as responsible as the duties of a County Surveyor's office. I don't know just how that can be done. I believe, however, that the office of County Surveyor in the State of Indiana ought to be clothed with some authority and respectability or else be abolished.

Mr. O'Brien: If you will pardon me, I would like to resent a little part of your eloquent address. I am not prepared to say quite yet that the people composing the counties of Indiana are in the habit of taking up the biggest dunderpates in their counties and electing them county surveyors. I believe they do select a reasonably good class of material out of which to make the surveyor. I don't know of a case where a thoroughbred jackass was ever elected county surveyor. [Laughter.] I do not think it worth while to discuss these questions any further, for we will not agree on them. I do think we ought to make a desperate attempt to unite upon some needed laws that are not to be intended for the good of the surveyor, but for the good of the people of the State of Indiana. Two years ago we abolished our Legislative Committee, and since then we have left

the Legislature severely alone. I do believe at this meeting we ought to unite on two laws, one concerning ditches for the good of the people who are suffering with ague in the northern and other parts of the State. We ought to agree upon a law to lift some people out of the mud. I believe we can present these matters to the Legislature this year, and it will not hurt us. I will move you, Mr. President, that we re-appoint a Legislative Committee to discuss two laws, one relating to drainage and the other to free gravel roads.

Mr. Faith: Mr. Chairman, I am a stranger to this Society, while my brother and myself have been doing surveying for some six years. I feel very much like my brother on the left (Mr. O'Brien) in regard to our work with the legislators. In regard to the matter of drainage in our county, Daviess, in the southern part of the State, in what is called "the pocket," we built a number of drains under the five-mile act. The law for the repairing and cleaning of those drains is the allotment law. The law under which we clean our drains seems to be very successful down there, and our citizens appreciate it very much and everybody has fallen in love with the allotment law. We have about one hundred miles of other drains that are being constructed under the five-mile act. A great many of the citizens of our county have discussed the matter of having some legislation changing the law so as to bring them under the allotment law. That, I think, would be a very valuable change.

Mr. Alter: I want to resent a little remark of my good brother about the ague in the northern part of the State. There has not been a case of ague there in the past five years. I believe, when it comes to that, the southern part of the State used to be as bad as the northern part. Perhaps the largest drainage scheme that has been carried out in the State for some time has been done by a single individual by the name of Gifford. About five years ago there was about twenty thousand acres of swamp land in our county. It was so swampy that the government surveyors refused to go on it to make the original survey. By means of the activity of

this gentleman, the Gifford law was passed so that he could get a little assistance from the parties benefitted, and whom he had not bought up. By some this law was known as the Illinois law modified to suit Indiana. Well, the court very promptly knocked that law out as soon as it came before it, and I think perhaps the court was right. Now, then, that same man, or his attorneys, will be here at this Legislature with a little amended act on the same general principles. Now, if the surveyors want anything of that kind, they should take that up. I think Mr. Gifford will be here personally to lobby a bill through in order to get a little assistance for what work he has done there already. The President made the remark that the drainage of the Kankakee region is an unsolved problem yet. It is unsolved simply because the financial ability to do it has not materialized. That country is rapidly getting into the hands of a few individuals, and whenever two or three men own the Kankakee country—which they no doubt will in the near future—the drainage of that river will be a small item, just the same as the drainage of this Pink-a-Mink swamp in Jasper County, and on which now they raise the finest crops.

So long as the surveyor's office is a constitutional office, you can not prevent any citizen running for that office. Brother O'Brien says that he never heard of a jackass being elected County Surveyor. Perhaps I will agree with you there, but I know a man who was elected County Surveyor that did not know a transit from a level. He did not know which end of the instrument to look into if he had to. He didn't even know the first principles; he had never been out with a surveyor. I ran his office for him three years myself. I have known of persons running for the office who had never been through Ray's Third Part Arithmetic, but fortunately they did not get the office. While those are a few cases, it is not the general thing. Our county surveyors compare in intelligence very favorably with other classes of men. I, for one, would be in favor of making it a licensed office, like that of County Superintendent. If it was a legislative office, then we could throw any safeguards around it we chose. I second the motion made by Mr. O'Brien.

Mr. O'Brien: If this surveyor elected for three years had been a skillful engineer, then Mr. Alter would not have had this three years work.

Mr. Morrison: Alter ought not to kick. (Laughter.)

President Goss: I want to beg Mr. O'Brien's pardon. In the main he is right. He only sees the county surveyors in his own immediate neighborhood and those who attend the meetings. I am a County Surveyor myself, and have been a number of years. The motion is, that the President appoint a committee to be known as the legislative committee, whose duty it shall be to consider questions relating to legislation on drainage and road laws, and not to consider any other laws, and said legislation to be for the benefit of the people of Indiana, and that said committee shall have power to act. Said motion was carried and the President appoints such committee—Messrs. O'Brien, Alter and Huckstep.

Mr. Romack: I believe I was misunderstood in regard to a legal corner. I meant a corner made a matter of record, and then the County Surveyor and sworn deputies are the only ones who have a right to make a legal corner.

President Goss: What is the custom of county surveyors generally, when out at work and find a corner of which there is no record; what do you do with it?

Mr. Alter: That depends a little on the lay of the ground. If I am somewhat anxious to have a corner there, I recognize it as a corner and make a record of it and charge them up for doing so. If it is recognized as a corner stone by the adjoining land owners, I consider it a corner in every sense of the word and as legal as it can be with the exception of it being on record. If they do not object, why I sometimes use an additional witness to it and make a record of it and charge them for establishing a corner. I find it is bad policy to move a corner or pass one that is recognized as a corner by the adjoining land owners.

Mr. Faith: I do not altogether take the view of some other speakers here, that because we find a corner that is so



regarded by the land owners we should make a record of it, especially when we have positive evidence of other corners showing it is wrong. I do not believe in such cases that we should recognize it. Where we have positive evidence that a corner is wrong, no matter who records it or where it is, I do not think that we, as surveyors, ought to regard it.

President Goss: In my practice not long since, I found a corner that was anywhere from two to two and a half rods from where it ought to be. One man's statement was that the stone had been there thirty-five years where it is now. I did not move the stone, and the matter was finally taken to the Court and the Court held that the stone should remain. There was no record of it anywhere.

Mr. Huckstep: Was that an original corner?

President Goss: No, sir; it was a forty-acre corner.

Mr. Huckstep: We always recognize rocks in the vicinity of quarter section and section "corners as being the corners, although the record don't show that there was ever any rock placed there.

Mr. Alter: Remove not the ancient landmark of your fathers.

Mr. Wagner: I think the Supreme Court has settled that case pretty thoroughly. I think you will find Supreme Court decisions in a number of cases where a line is fixed by a fence, and where this line crosses another has been in some cases decided as a corner. It makes no difference whether the measurement will fix it there or not.

Mr. Faith: That I would regard as a court line; I do not regard that as a line that surveyors should depend on. In my work, I take the best obtainable evidence of work that was done before me, and from that make my corners and lines. I believe that the courts should establish lines and not the surveyors. After the matters have gone through the court, then if the surveyor is asked to set the corners according to the court's decision, it is all right.

Mr. Romack: I have found a good many corners in my county where there is no record of them, and if I were called

upon to establish a corner on a forty-acre tract of land, and I find the corners not in the right place, I never remove them.

Mr. Fatout: We had one case in this county. One man never had a deed for the land, never paid any taxes on it; but another did have a deed and did pay taxes on it, and he partly had possession of it. It was not entirely fenced, only as the river fenced it. They went into court and the man who had possession of it got a deed. There was another case here. A few years ago, just west of the city, a man had a deed for land in one section; another one had the adjoining section. By some hook or crook a fence had taken in an acre or perhaps two acres of one, and from the adjoining section. The man who had the deed tried to get it back, and he failed simply because it had been fenced up for years. The courts nearly always hold that where a man has had peaceable possession for twenty years he can keep it, and I don't know that a surveyor is justified very much in changing those lines. Of course, he can tell those parties where those lines should be, but as to establishing lines, he had better not do that.

Mr. O'Brien: It is not the duty of the surveyor to go out and establish the property rights of any person. The surveyor has no more jurisdiction than the sheriff, the coroner or the commissioners.

Mr. Fatout: One instruction is given to the government surveyors, and that is, to find the original corner, if it is possible to do so, and it is your duty to place your corner there, no difference how incorrectly the original corner was placed. Down near Martinsville there was an old hedge fence and the old corner stone had been there, the witnesses testified, for thirty-five or forty years. The hedge fence had grown up on the line. All that distance was described as fifty rods off the north side of the quarter section, and instead of being fifty rods it was fifty-two. Well, they got into a dispute over it, and I guess the dispute is not settled yet. One man found out there was a surplus and he went to work and made everybody party to a suit. That, of course,

quieted the title to that strip of land. In a few days after that the other party took a notion to have that corner correctly placed, and the order was for the County Surveyor to establish the corner. He did so, but the matter got into the courts. I was appointed to run over those lines, and I was ordered to ignore the first decision quieting the title. I made my report, sticking to the old corner that had been there forty years. The Supreme Court reversed the decision of the lower court and placed the decision quieting the title as correct. So, you see, old land matters do sometimes change old corners.

Mr. O'Brien: Do you recommend that a surveyor should at any time go out and try to establish property rights?

Mr. Fatout: No, sir; it has got so now that I ask a man if there is any dispute about his line, and if there is any fence there; and if the fence has been there twenty years, there is no use to take a surveyor out. Of course, the surveyor can say where the lines should be. I think it is best for the surveyor to stay out of the dispute. This is better than to go in and establish a corner and then have it set aside.

Mr. Alter: I agree with the last remarks of Mr. Fatout. I live on a prairie somewhat irregular, a portion of it being about twenty-five by thirty miles in area, and in that entire district I think there are perhaps two or three corner witnesses of the government survey. There were no records in our county up to 1866; in Benton County the records date back a little older than that. Now, when we go out there to survey and we come to the section corner, we are very glad to find any kind of stone in the cross-roads. We do not stop to question whether it is the proper distance from the other corners or not. Now, for instance, in one township the sections from the west side are from twenty-five to thirty-five rods short.

## STRAY THOUGHTS.

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BY R. A. HOWARD.

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It seems strange that people are so slow to learn. Members of the engineering profession are in the same boat. There is very little improvement in the form of our streets, sidewalks and roads in the last fifty or sixty years. It is true we have better roads and streets, but that is because we use better materials.

In 1835-7, the national road was built through this county, and through the towns the streets were paved with limestone set on edge. In our former county seat, six miles from here, there are several squares of that pavement still in existence. In those portions of the street where the greater travel wears the softer stones, making the roadway uneven, it is evened up from time to time with a coat of gravel, and by this means, the foundation being substantial, a very good road is kept up.

About three years ago, our city not being properly quarantined, the brick-paved-street-fever got quite a hold on the people. In fact, it became so severe that it was thought best to send a committee of the Council, and some others, on a junketing tour to Columbus, Ohio, and neighboring cities, to see what was best to be done for the malady. But it was an unnecessary waste of the people's money, for right in the former seat of our own county, within six miles of us, is the same pattern of street put down in 1835-7. But there was one idea the committee got onto which has been adopted here, which, no doubt, ought to be commended, and that is one of the worst forms of sewer inlets that could be thought of. Perhaps I should not say the worst form of inlet, but the position on the street is the very worst possible, they being at the corners of the streets.

Twenty-six years ago last June, the writer was appointed to the office of City Civil Engineer of this city, Richmond, Ind. But where was the office? It was on the street, side-



walk, or wherever you might meet anyone having business with you. There were no records, no profiles, no,—well, we did have the streets and sidewalks to go by; but it was very much like surveying a lot in a good many towns and cities now, about the best thing you can do, there being no monuments, is to set up a couple of stakes, shut both eyes and guess at it.

Well, some of the property owners wished stakes set for improving their sidewalks. They were sent to the Engineer; he asked the Street Committee and Council what was best to be done in the matter. He was told that all he had to do was to set the stakes. That it was a very simple thing to do, they had seen the other Engineer set stakes and all there was of it was to get some stakes and a hammer, set the stakes in the ground and drive them down to the proper grade and the thing was done. He asked what slope to give the sidewalks. "Huh, give them the proper slope, of course; an Engineer ought to know that much." Upon investigation it was found that the "proper slope" for the sidewalks, taking existing walks for a pattern, to be anything, from about six inches to fifteen, in from ten to twelve feet. So the Engineer found himself in about the same fix the surveyor was when the two farmers wanted him to put a stone down for a corner that was common to four quarter sections and at the same time have it stand in two places, two rods or more apart; for the sidewalks had to slope so as to come to certain points on the door steps of the different store rooms, no matter what the elevation of the different steps were.

After consulting with some friends, the Engineer fixed the slope of the sidewalks at one-quarter of an inch to the foot, or as near to that slope as circumstances would permit. Then there was a howl. It would never do, the water wouldn't run off, the people would have to wade, etc. The Engineer told them that a walk with a slope of one-quarter of an inch to the foot had more than four times the slope that some of the gutters along the street had, and the gutters were not as smooth as the sidewalks. The answer was,

"Well, I don't know anything about that, but I know they won't do, they are too flat and they will have to be taken up and relaid." None, however, have been taken up on that account, but more or less have been put down at that slope every year since, until last year our wise city fathers concluded that they must have an ordinance regulating the slope of the sidewalks. So the Board of Public Improvements, or rather non-improvements, made an examination of the walks in the city; took quite a number of levels and finally came to the conclusion to make all sidewalks with a slope, or fall, of one-quarter of an inch to the foot, from the lot line to the curb.

Before the ordinance was passed, in a conversation with a member of the Board, the writer asked if it would not be better to modify the ordinance a little so as to read at that slope, or as near to that slope, or as near to that as circumstances would permit, and not require an impossibility of the engineer in setting stakes. But the Board is doing the engineering now, and they can do things that the ordinary engineer would not think of doing, so the ordinance was passed as it was.

We have better paving brick than we had twenty-five years ago and there is no necessity of as much slope in the sidewalks as was given them. And we have cement walks, which ought not to have more than one-half hundredth of a foot to the foot, for the nearer level they are the better, especially when covered with ice, and then you have double the fall you often have in the street gutters. The snow, slush, or mud would not run off the walk if it had a slope or fall of three feet in ten, and water would run off if there was an eighth of an inch fall in ten feet, in fact the water would not lie there if the pavement was absolutely level. On account of the wear it would be as well to arch the sidewalk about the eighth of an inch for cement, and a quarter of an inch for brick walks. Sidewalks should have from eight to twelve inches of gravel and sand under the brick, depending on the nature of the soil of which the sub-grade is composed.

Sidewalks ought to be continuous, with no breaks or steps at the intersecting streets or alleys, so that when a person gets on the walk they could go from one end of the street to the other without stepping up or down an inch. We had such walks in our city before the brick-paved streets were put down. The Board was asked why they wished to ruin our sidewalks. The answer was that they had seen them put down that way in Columbus. Great Caesar! because they cultivate their fields with forked sticks in some of the eastern countries we must give up our plows. But none of them would take any stock in a company to be formed for the purpose of introducing the forked sticks, although told that they could be brought here free of duty, notwithstanding the McKinley bill.

Main street in our city is on a ridge, and a majority of the intersecting streets carry the water away from it. When it was being paved with brick the Board was asked why the walks could not be made continuous across those streets where there was no water and therefore gutters were not needed? The answer was that they had to provide for the water in some cases, and for the sake of uniformity they made the others that way also. Like the man who had a spoke or two broken out of one of the wheels of his fine carriage, breaks some out of the other wheels to make them alike.

Perhaps it may not be out of place for me to give a few stray thoughts on streets and roads, as that subject seems to be coming to the fore, as evidenced by the proceedings of the Michigan Engineering Society for 1892, where there were eighteen papers read and thirty-six pages of discussion on the subject.

It does seem strange that the people are so slow to learn. You may take a ride in the country, and you will find the high-crowned roads that you cannot drive on only in the middle, cut into ruts and full of mud holes. Occasionally you will find a road nearly level in cross-section, nice and dry, and you can drive anywhere on it and pass other vehicles at a trot, while on the high-crowned roads, when you

meet others driving, you have to check your speed and pass very carefully, for fear of overturning. People will drive over these miserable, high-crowned roads year after year, and when they come to build one themselves, they will make it just like the old ones. Why is it that people will spend so much time and money in making poor roads, when they could have good roads at less cost, besides saving quite a sum yearly in the wear and tear of vehicles and horse flesh?

The writer, in 1868, had quite a time with the property owners along the line of a street he was constructing. In cross-section the sub-grade was level from gutter to gutter, forty feet. The gravel was ten inches at the sides and sixteen inches in depth at the center, making a crown of six inches. While the grading was going on, the property owners lobbied the Council, telling it that the engineer was ruining their property. But there has been no complaint since it was finished, for it was one of the best streets in the city, and since then the streets have been made nearly on the same plan. I suppose one reason the property owners kicked was, that it was so different from the streets built before, for the old streets had a crown of one foot in the sub-grade from gutter to gutter, with six inches of gravel at the sides and twelve inches in depth at the center, making a crown in the finished street of eighteen inches, regardless of the width of the street.

In the brick-paved streets, some engineers recommend that the center of the street should be on the same level with the curbs. But why this should be so, none of them give any reason. Take a street that is forty feet from curb to curb, with a curb six inches above the gutter, it would give a fall from the center of the street to the gutter of one in forty, which is as much as, or more than a good gravel street ought to have, and certainly twice as much as a brick-paved one should have, for the nearer level they are the better. When the center of the street is as high as the curb, of course the intersecting street would be the same, and in case the sewer inlets should become clogged, as they sometimes do



in very heavy rain storms, the water would overflow the sidewalks and fill the cellars, thereby causing more or less damage. Why not have the street, in cross-section, with a six-inch curb, a crown of two or three inches, leaving the center of the street three or four inches lower than the curb? Then, if the sewer inlets get choked, there would be a chance for the water to go down the street without causing any damage, even in an extraordinary rain storm.

Some recommend that in brick-paved streets the surface should be arched and conform to a true circle, but none of them gave a reason for it. Perhaps they are like the Committee of our City Council, "seen some streets somewhere made that way." But, surely, the circle is one of the worst possible forms in which a street can be made. Take a street which is forty feet from curb to curb, six inches rise in the center, circular, you have near the sides a half-inch fall to the foot, making it unpleasant driving on, besides grinding the surface of the brick away, extra wear upon vehicles and increasing the draught on your horses. Take the same width street, make a two or three-inch rise, in straight lines from curbs to center, easing off at the apex a little, you would have a street that you could drive on any part of with equal comfort and facility. And that street would carry off nearly twice as much water as the other. The only crowning admissible would be about half an inch on each side, on account of the extra wear, there being more travel toward the center of the street than near the sides.

I stated that the engineers gave no reason for arching the street in cross-section, and I wish to correct that statement. One of them, in describing the manner of constructing a brick-paved street, says: "I now say just here, that it is all-important that the bottom of the curb be solid, that the lower course of brick be tight to the curb and tight in all of the joints across the entire width, also that the upper courses be laid end to end, and when six, eight or ten courses have been laid, that they be keyed together very tight across the street, *as this is the main support of the arch or crown of the*

street." Let us look at this a moment. Trautwine gives a rule for determining the depth of the key for arches, that makes the depth in this case (fifty feet span, with a six-inch rise) nearly seven feet. And the same author's rule for finding the thickness of an abutment to withstand the thrust or an arch, gives, in the above case, nearly one hundred and twenty-five feet. And yet engineers are depending on an arch with a four-inch key and a stone five or six inches thick, backed up with a little gravel supported with soft earth for "*the main support* of the arch or crown of the street." I suppose that "main support" means something over one-half. Then suppose we say four feet for the key and seventy-five for the abutments, there is still quite a difference between Trautwine's rules and some engineers' practice. The writer's experience while superintending the laying of brick on the first brick-paved street put down in his own city, goes to show that this arching don't cut much of a figure in supporting the crown of the street; in fact, it doesn't amount to a very diminutive zero ( $^{\circ}$ ). The specifications required the usual arch and the brick to be keyed tight between the curb and the rail of the street car track. A few trials convinced the writer this arching, so far as preserving the crown of the street is concerned, was all a mistake, for when we got our brick keyed up and tried the rammer, we found as the rammer forced the brick down immediately under it, that the brick in other places would rise up, and after the blow was struck, in the rebound, the brick under the rammer would follow it up; and the more we pounded the more it got no better. And every passing load along the street would produce about the same result as the rammer; so the keying business was abandoned as of no practical utility whatever.

And some engineers recommend that in cross section the surface of the street should be a true circle and that the subgrade should conform to the surface. And yet, I suspect that if those same engineers had two streets to build, one to accommodate a small amount of light traffic and the other a large amount of heavy traffic, they would not follow

their own recommendation, but would put a greater amount of metal in the foundation of the street that was expected to withstand the greater and heavier traffic. One of the best roads the writer ever helped to build was, in cross section, width of gravel, eighteen feet; depth at sides, six inches; and at center, fourteen inches, with a crown of two inches, making the subgrade six inches lower in the middle than at the sides, and where drainage was necessary, a drain tile was put down in the center, three and a half or four feet below the subgrade and the trench filled with gravel.

Some of the advantages of the low crowned over the high crowned roads are, it costs less to build them and less to maintain them; they do not wear out so soon; horses and vehicles last longer and do more work. They dry out weeks before the high crowned ones, for the reason that there are no deep ruts and mud holes; for on the high crowned road, every passing vehicle makes the rut or mud hole deeper, there being only one track to drive in; while on the low-crowned road you can drive anywhere, and consequently they are not cut into deep ruts and mud holes, and places that do hold water are very shallow and soon dry up. Take a low crowned road that needs to be re-graveled, put from four to six inches of gravel on it, and with very little attention it soon becomes packed down smoothly so that you can drive anywhere on it and you have a good road the year round. On the other hand, take one of the hogback roads, put on a third more gravel piled up in the middle, there being but one place to drive, there will soon be three gutters and four ridges to worry horses over and there is no time of the year that you have a good road.

Now let me give you a specimen of our Board's sewer engineering so that you will have no excuse for not building first-class sewers hereafter. We have, on one of our streets, two sewers, one for storm water and the other for sewage. The one for sewage is a twelve-inch pipe. The Engineer drew plans for a lateral, ten inches part way, to finish toward the upper end with an eight-inch pipe. Some of the property owners concluded that as they paid for it they ought to

have a larger one. The Board got into a wrangle with the Engineer about it so he resigned, and the Board offered a resolution in Council changing the Engineer's report so as to read eighteen inches instead of ten and fifteen in place of eight. One member moved to amend by inserting twenty for eighteen and eighteen for fifteen. There was a tie vote and the Mayor voted for the amendment. Well, that sewer was built last year, twenty-inch running into a twelve.

Talking with a member of the Board one day, he remarked that they would probably have to take up the twelve-inch some time and put in a larger one. I said to him, you had better take it up now, for if you wait a few years most likely you will have both to take up. He said they could flush it and keep it clean. I wanted to know how he could flush the sewer when there were gates to prevent the water backing into the cellars and vaults. I said further, suppose you could flush it and force the water through the twelve-inch pipe at the rate of six feet per second, it would clean it out very nicely; but while the water is going through the twelve-inch at that rate, it will only go through the twenty-inch about two feet per second, and it won't clean that out. This plan for sewers appears to be more of a anti-heterononsensical than one of Brother Whitten's heterodoxicals. But when the people become civilized there will be no more sewers built to carry off sewage.

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## A PLEA FOR THE PONDS OF MY CHILDHOOD.\*

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BY JOHN E. ALTER.

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I am very happy to greet each other, and meet so many of my friends so near the beginning of the first of the year. I hope no one will expect me to keep exactly to the point, simply because I have been appointed to write on this sub-

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\*This paper when printed in cold type loses the inimitable dialect (German) in which it was read by the author, but which, as delivered to the Society, "brought down the house."



ject. If you do, you will be disappointed. I hope you see the point. But I will now loosen the needle of my imagination, take my bearings and establish "A Plea for the Ponds of My Childhood."

Man is a creature of education, whether his conscience is or not. As the twig is bent, so will it crook. I was born, raised and educated on the mossy banks of a millpond, which was fed by a hundred marshes in Northern Jasper, lulled to sleep a hundred moons by the croak of the bullfrog and the hum of the mosquito. What more beautiful sight than to see a large pond, interspersed here and there by patches of wild rice, richly-colored blue flag and nodding calamus. Inhabited by the furry-coated muskrats, with their cities of a thousand houses, all built of nature's own product, the long, green mosses and rushes from the water. As your little boat glides gently over the surface of the water, you see the cunning tadpole, the glass-eyed dog-fish, the water moccasin snake, immense water beetles, turtles, snails and clams. What sport to pursue the muskrat with traps in spring and autumn and with spear in winter. These ponds make good places to water the cows when there is no wind-pump. They make great skating parks in winter and swimming parks in summer. Oh, my kind friends, when all the evidential facts strike you in the face, who would not make a plea for the ponds of his childhood?

'Tis true, I have many a time taken a swim in one of these same ponds, where the green scum parted by my neck on the surface of the water, till it made a wake behind like a steamboat of nineteen tons burden; then I crawled out on the bank with a headache and blues, water ringing in my ears, dress myself and sit in the sun on the sandy bank of the pond until I shook with ague about four hours and a half, and take quinine all next day and the third day shake again, and so forth, till the snows of winter drove the ague out of my system and the quinine settled in my bones. But these are trifles compared with the enjoyment you get from a string of ponds around the house, where the ducks and geese can swim and dive with ease.

My neighbor has plowed around some ponds in his corn-field for twenty years and lost several crops when the water got too high, and still he loves those ponds. I know a man who has plowed around an old log in the middle of his field for over ten years. Don't you suppose he is better acquainted with that log and thinks more of it than he did at the first? Habits make customs, and long acquaintance makes friends. O, ye engineers and drainage commissioners, we can't help but look on you as our enemies, seeking to rob us of our old landmarks.

“How dear to my heart are the scenes of my childhood,  
When fond recollection presents them to view;  
The sloughs, the marshes, the deep, tangled wild-wood,  
And every loved spot which my infancy knew,  
The wide-spreading pond and the mill that stood by it.”

But now another tear swells my heart, for,—

“I've wandered to-day o'er the hill, Maggie,  
To watch the scenes below,  
The creek and the creaking old mill, Maggie,  
As we used to long ago.  
The mill-pond is ditched out and gone, Maggie,  
Where all our sports begun,  
The creaking old mill is still, Maggie.

Good people, it is not to me alone, but even ducks and geese make a plea for the ponds of their childhood. I like Sam Rogers, because he said,—

“Mine be a cot beside the hill,  
A beehive's hum shall soothe my ear,  
A willowy brook that turns a mill,  
And a pond where ducks can swim all the year.”

But this grand picture is changed as soon as the county commissioners send out the viewers and surveyor. They go staking, estimating and assessing, as if they were monarchs of all they surveyed. Next comes the report, consisting of bottom and top grades, benefits, costs, bench marks, source, outlet, dollars and cents, what everybody have to pay. Then come the contractors and cut big holes here and there across the meadow and cornfields, and in a couple of years they

have it done. Then away goes the water, farewell to the rippling wavelets, nothing left but a barren waste; even the frogs hop away in disgust. When the water is taken away from the grassy marshes, nothing but weeds will grow until you plow and plant. Drouth sets in during the summer of the year, and the engineer comes around looking for a job of irrigation. "Oh, give me back the ponds of my childhood." I sometimes feel like Jacob of old, when Joseph went down into Egypt, "If I am bereaved, I am bereaved." I would be very willing also to send down my other son, Benjamin, to the commissioners with a little spices, a little taffy and a few huckleberries, if I thought they would restore to me the ponds of my childhood.

In the name of common sense, only think of it, a man owns nothing in the world but a pond of water, and, against his will, they take even that away from him and charge him for doing it. The scriptures command you to cast your bread upon the waters, and it shall return unto you before many days. Now, how will you throw it if there is no water to cast it upon. Nature knew what she was doing when she made this country; the men must get awful smart and change everything.

The northern end of our county was once covered with beautiful ponds and marshes; now it is covered with waving fields of corn and oats every year. These men are becoming very rich, which is very wrong, for the Bible says it is easier for a camel to get through the eye of a needle than for a rich man to be saved, so of course this business is all wrong. I hope, if the legislature now in session touches upon upon the ditch law, they will do unto others as they would have others do unto them, for all former laws on the question of drainage have been bits of advice to the viewers and engineers to do others before they do you.

Now, good people, others may do as they like, but as for me and my house, like Daniel of old, with our faces toward the capitol three times a day, if needed, will we make a plea for the ponds of our childhood.

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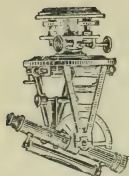
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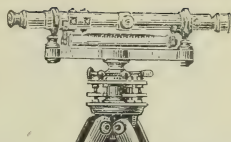
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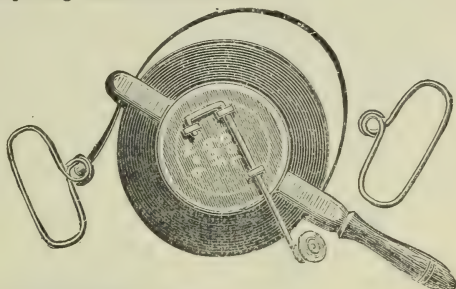
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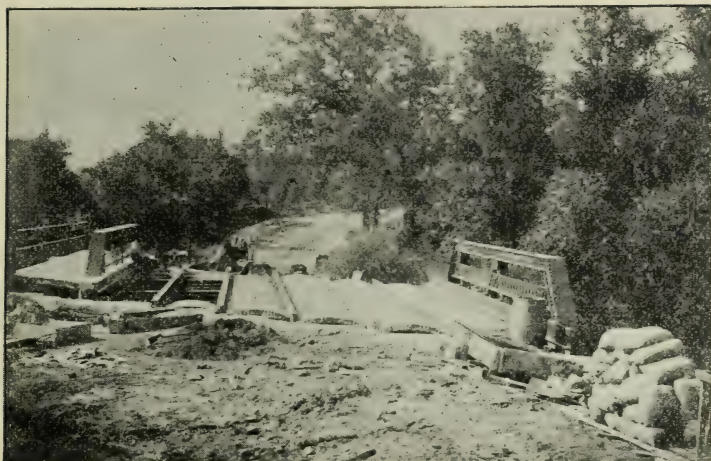
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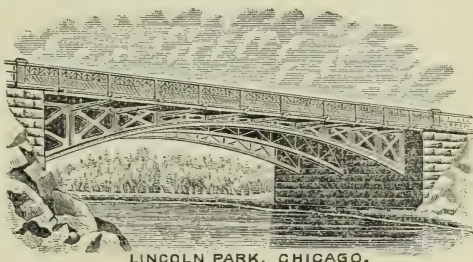
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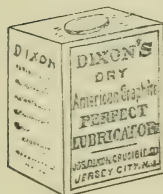
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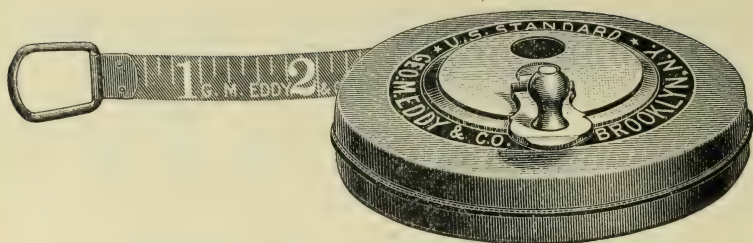
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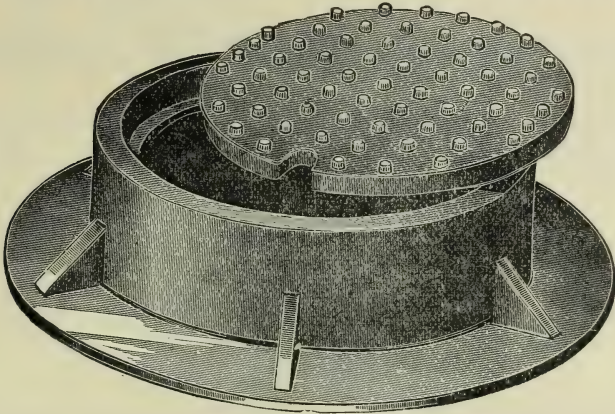
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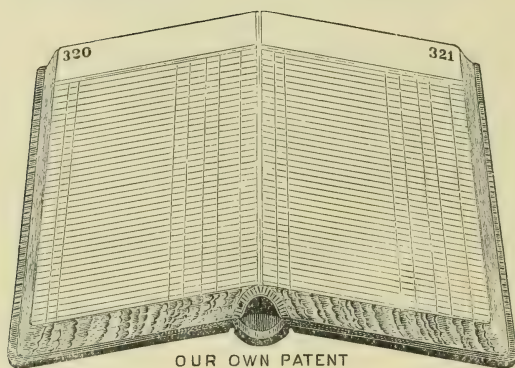
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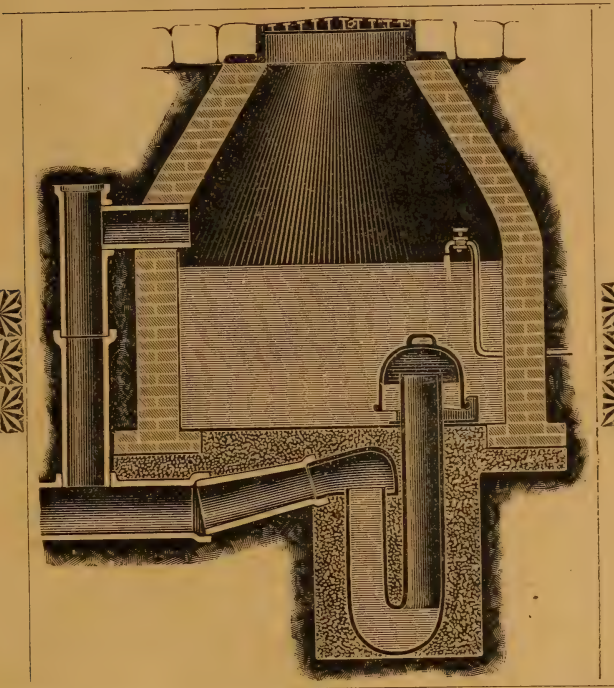
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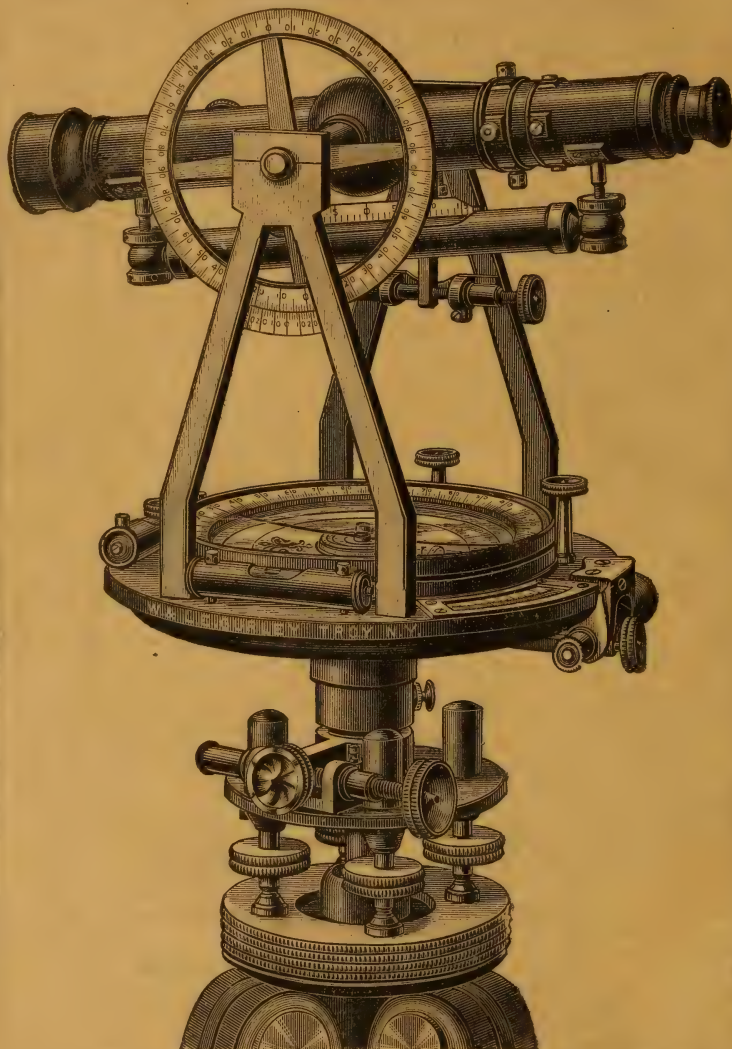
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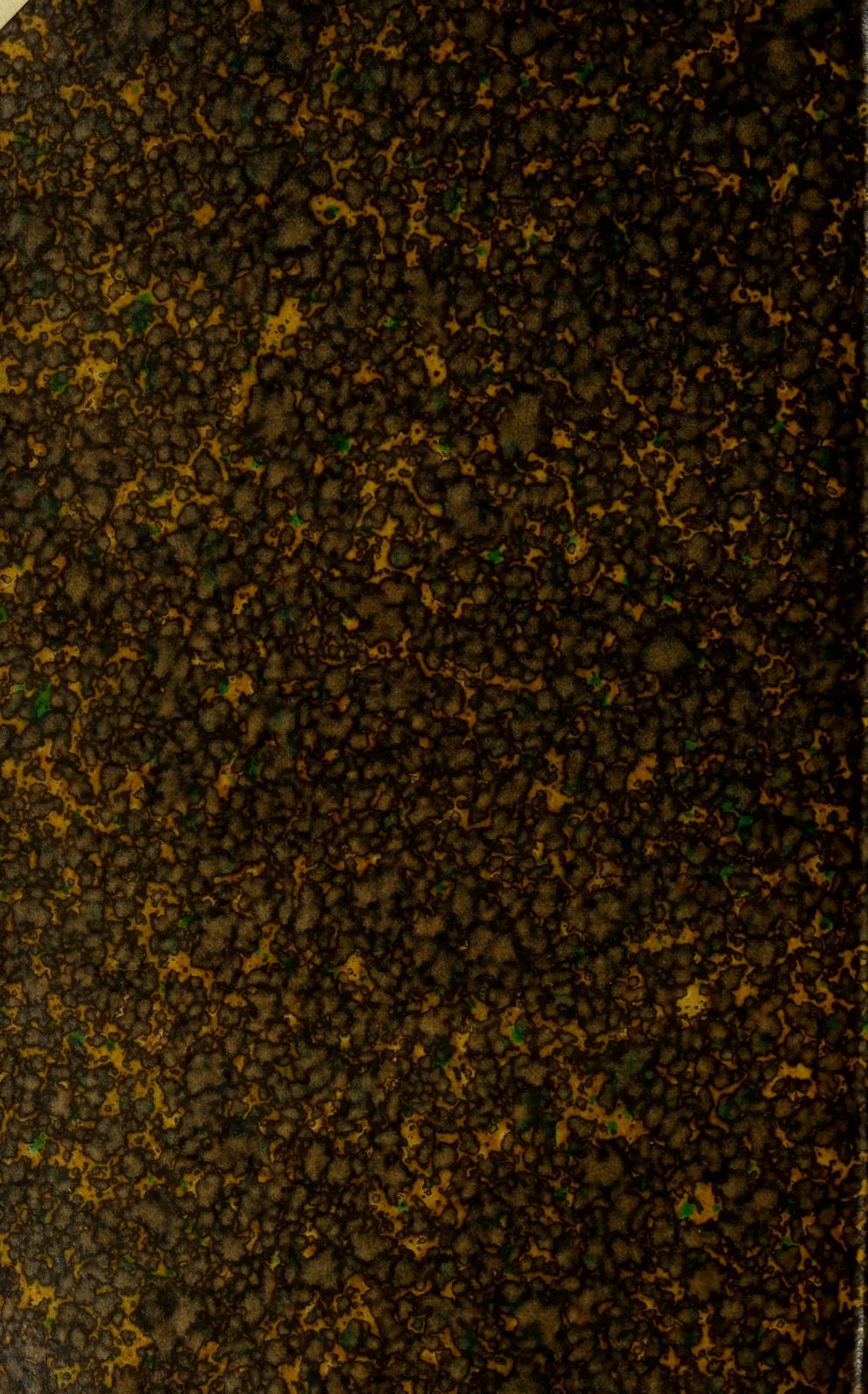
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